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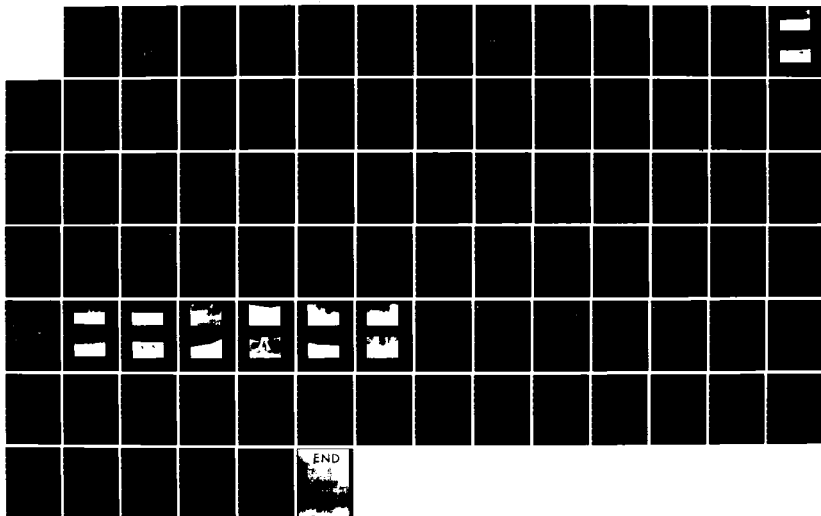
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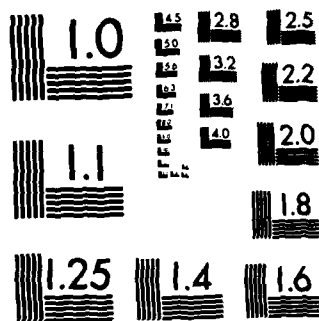
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POMPERAUG RIVER BASIN  
BETHLEHEM, CONNECTICUT

BRONSON E. LOCKWOOD RESERVOIR DAM  
CT 00435

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
WALTHAM, MASS. 02154

MARCH 1980

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER CT 00435	2. GOVT ACCESSION NO. ADP144 585	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Bronson E. Lockwood Reservoir Dam  NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Pomperaug River Basin Bethlehem, Connecticut		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Bronson E. Lockwood Dam is a zoned, rolled earth embankment about 820 feet long with a maximum height of about 34 feet and a top width of 16 feet. B.E. Lockwood Dam has a maximum storage capacity of approximately 1,290 acre-feet and a maximum height of 34 feet. Therefore, the dam is classified in the "Intermediate" size category. The dam appears to be in good condition.		



DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
424 TRAPELO ROAD  
WALTHAM, MASSACHUSETTS 02154

REPLY TO  
ATTENTION OF  
NEDED

MAY 30 1980

Honorable Ella T. Grasso  
Governor of the State of Connecticut  
State Capitol  
Hartford, Connecticut 06115

Dear Governor Grasso:

Inclosed is a copy of the Bronson E. Lockwood Reservoir Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, Watertown Fire District, Watertown, Connecticut 06795.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely,

  
MAX B. SCHEIDER

Colonel, Corps of Engineers  
Division Engineer

Incl  
As stated

BRONSON E. LOCKWOOD DAM

CT 00435

POMPERAUG RIVER BASIN  
BETHLEHEM, CONNECTICUT



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PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

## NATIONAL DAM INSPECTION PROGRAM

### PHASE I INSPECTION REPORT

Identification No.	CT 00435
Name of Dam:	Bronson E. Lockwood Dam
Town:	Bethlehem
County and State:	Litchfield, Connecticut
Stream:	East Spring Brook
Date of Inspection:	November 20, 1979

#### BRIEF ASSESSMENT

Bronson E. Lockwood Dam is a zoned, rolled earth embankment about 820 feet long with a maximum height of about 34 feet and a top width of 16 feet. The riprapped upstream slope is 2.75H:1V and the grassed downstream slope is 2.25H:1V. The drop-inlet service spillway and outlet works are combined in a reinforced concrete intake tower located near the center of dam at the toe of the upstream slope. A grass-lined trapezoidal auxiliary spillway is located at the left abutment. The impounded waters are used for water supply for the Watertown Fire District.

B.E. Lockwood Dam has a maximum storage capacity of approximately 1,290 acre-feet and a maximum height of 34 feet. Therefore, the dam is classified in the "Intermediate" size category.

The normal pool behind the dam is about 2,800 feet long and has a surface area at the service spillway crest of 67 acres. The drainage area above the dam is 1.40 square miles. Two private dwellings are located about 2.9 miles downstream of the dam. A failure of B.E. Lockwood Dam could cause excessive property damage and the possible loss of more than a few lives at the damage center. Therefore, the dam is classified in the "High" hazard category. The recommended test flood for an "Intermediate" size, "High" hazard dam is the full Probable Maximum Flood (PMF).

The dam appears to be in good condition. The root systems of the small trees growing on the upstream slope near the right abutment may displace the riprap exposing the embankment to wave action and erosion. The heavy vegetation growing in the emergency spillway approach channel reduces the emergency spillway discharge capacity.

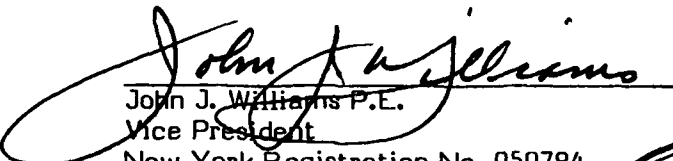
The test flood peak inflow to B.E. Lockwood Dam was computed as 2,930 cfs. The routed test flood outflow of 2,590 cfs overtops the embankment by 0.5 feet. The spillway system is capable of discharging 1,240 cfs prior to overtopping of the embankment, which is about 48 percent of the routed test flood outflow.

The routed outflow for one half of the PMF is 670 cfs which would peak at a level 1.6 feet below the crest of the dam.

It is also noted that a flood equivalent to 75 percent of the PMF could be routed through the dam without overtopping the dam.

Within two years after receipt of this Phase I inspection report, the Owner, the Watertown Fire District, should implement the following operation and maintenance measures: 1) remove the small trees growing on the upstream face of the dam; 2) cut the heavy vegetation growing in the emergency spillway approach channel and regrade or drain the area; 3) develop a formal surveillance and flood warning plan, including round-the-clock monitoring during heavy precipitation; and 4) institute a program of annual technical inspection.

O'BRIEN & GERE ENGINEERS, INC.

  
John J. Williams P.E.  
Vice President  
New York Registration No. 050794

Date: 14 APRIL '80





This Phase I Inspection Report on Bronson E. Lockwood Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

*Richard J. DiBuono*

RICHARD DIBUONO, MEMBER  
Water Control Branch  
Engineering Division

*Aramast Mahtesian*

ARAMAST MAHTESIAN, MEMBER  
Foundation & Materials Branch  
Engineering Division

*Carney M. Terzian*

CARNEY M. TERZIAN, CHAIRMAN  
Design Branch  
Engineering Division

APPROVAL RECOMMENDED:

*Joe B. Fryar*

JOE B. FRYAR  
Chief, Engineering Division

## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

## TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
Letter of Transmittal	
Brief Assessment	
Review Board Page	
Preface	i
Table of Contents	ii-iv
Overview Photo v	
Location Map	vi

## REPORT

### 1. PROJECT INFORMATION

1.1	General	1-1
	a. Authority	1-1
	b. Purpose of Inspection	1-1
1.2	Description of Project	1-1
	a. Location	1-1
	b. Description of Dam Appurtenances	1-2
	c. Size Classification	1-3
	d. Hazard Classification	1-3
	e. Ownership	1-3
	f. Operator	1-3
	g. Purpose of Dam	1-3
	h. Design and Construction History	1-3
	i. Normal Operating Procedures	1-3
1.3	Pertinent Data	1-3
	a. Drainage Area	1-3
	b. Discharge at Damsite	1-3
	c. Elevation	1-4
	d. Reservoir Length	1-4
	e. Storage	1-4
	f. Reservoir Surface	1-5
	g. Dam	1-5
	h. Diversion and Regulating Tunnel	1-5
	i. Spillway	1-5
	j. Regulating Outlets	1-5

## TABLE OF CONTENTS (Con't)

<u>SECTION</u>	<u>PAGE</u>
2. ENGINEERING DATA	
2.1 Design	2-1
2.2 Construction	2-1
2.3 Operation	2-1
2.4 Evaluation	2-1
a. Availability	2-1
b. Adequacy	2-1
c. Validity	2-1
3. VISUAL INSPECTION	
3.1 Findings	3-1
a. General	3-1
b. Dam	3-1
c. Appurtenant Structures	3-1
d. Reservoir Area	3-1
e. Downstream Channel	3-2
3.2 Evaluation	3-2
4. OPERATIONAL AND MAINTENANCE PROCEDURES	
4.1 Operational Procedures	4-1
a. General	4-1
4.2 Maintenance Procedures	4-1
a. General	4-1
b. Operating Facilities	4-1
4.3 Evaluation	4-1
5. EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES	
5.1 General	5-1
5.2 Design Data	5-1
5.3 Experience Data	5-1
5.4 Test Flood Analysis	5-1
5.5 Dam Failure Analysis	5-2

## TABLE OF CONTENTS (Con't)

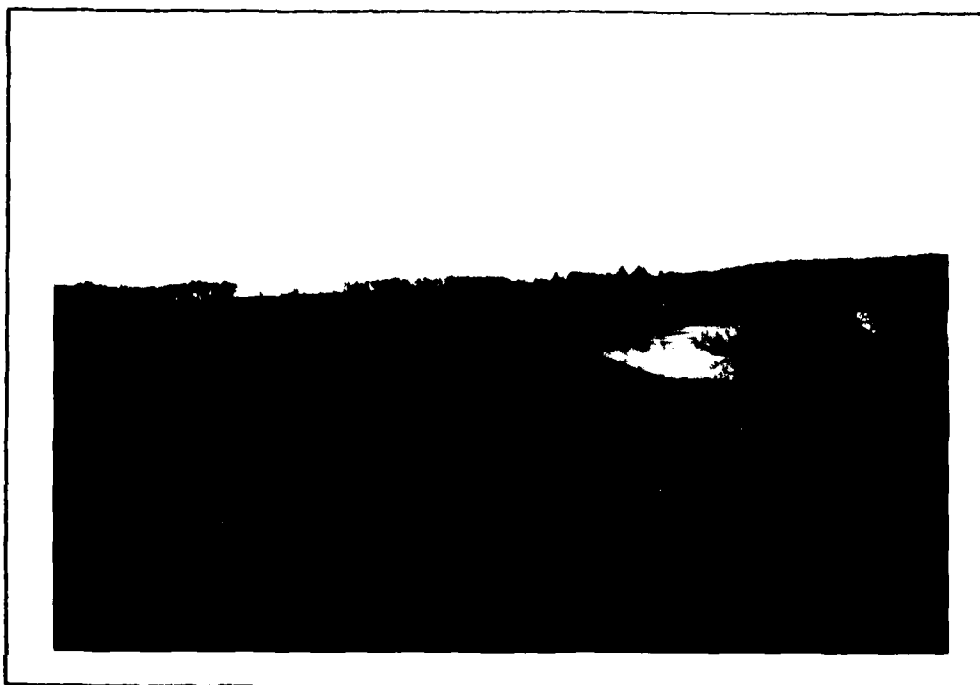
<u>SECTION</u>	<u>PAGE</u>
6. EVALUATION OF STRUCTURAL STABILITY	
6.1 Visual Observation	6-1
6.2 Design and Construction Data	6-1
6.3 Post-Construction Changes	6-1
6.4 Seismic Stability	6-1
7. ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES	
7.1 Dam Assessment	7-1
a. Condition	7-1
b. Adequacy of Information	7-1
c. Urgency	7-1
7.2 Recommendations	7-1
7.3 Remedial Measures	7-1
a. Operation and Maintenance Procedures	7-1
7.4 Alternatives	7-1

## APPENDICES

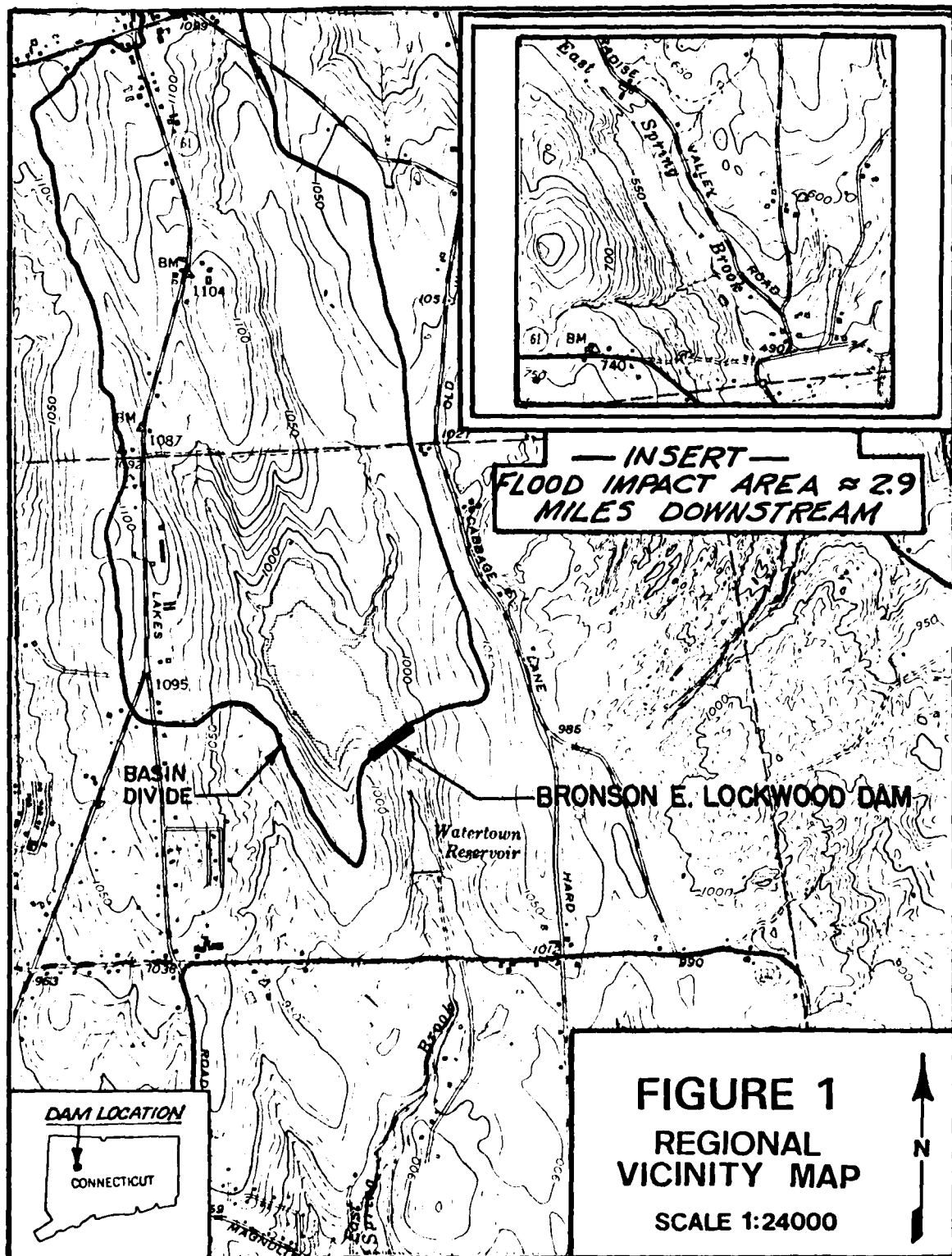
APPENDIX A - INSPECTION CHECKLIST	A-1 to A-11
APPENDIX B - ENGINEERING DATA	B-1 to B-12
APPENDIX C - PHOTOGRAPHS	C-1 to C-6
APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS	D-1 to D-22
APPENDIX E - INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS	



OVERVIEW OF THE DAM AS OBSERVED FROM THE DOWNSTREAM  
END OF THE EMERGENCY SPILLWAY. (11/20/79)



VIEW ALONG THE TOP OF THE DAM AS OBSERVED FROM THE  
EMERGENCY SPILLWAY WHICH IS IN THE LEFT ABUTMENT. (11/20/79)



NATIONAL DAM INSPECTION PROGRAM  
PHASE I INSPECTION REPORT  
BRONSON E. LOCKWOOD DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspections throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of the dams within the New England Region. O'Brien & Gere Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the state of Connecticut. Authorization and notice to proceed were issued to O'Brien & Gere Engineers, Inc. by a letter from the Corps of Engineers dated November 6, 1979 and signed by Colonel William E. Hodson, Jr. Contract No. DACW33-80-C-0014 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection. The purpose of performing technical inspection and evaluation of non-federal dams is to:

1. Identify conditions which threaten public safety and make the Owner aware of any deficiencies to permit him to correct them in a timely manner.
2. Encourage and prepare the states to initiate effective dam safety programs for non-federal dams as soon as possible.
3. Update, verify, and complete the National Inventory of Dams.

1.2 Description of Project (Information for this dam was obtained from the Watertown Fire District, Malcolm Pirnie, Inc. and the State of Connecticut, Department of Environmental Protection (DEP)).

a. Location. Bronson E. Lockwood Dam is located on East Spring Brook within Bethlehem Township, Conn. Two private dwellings located about 2.9 miles downstream are considered to be the major damage center. East Spring Brook discharges into the Nonewaug River about 3.5 miles downstream of the dam and the Nonewaug River joins the Pomperaug River about 8.8 miles downstream of the Dam. The dam is shown on the USGS Quadrangle entitled "Litchfield, Conn." at coordinates N41°39.5, W73°11.2'. A regional location plan of B.E. Lockwood Dam is enclosed as Figure 1, page vi.



b. Description of Dam and Appurtenances. B.E. Lockwood Dam is a zoned earth embankment approximately 820 feet long with a maximum height of about 34 feet. The top of the dam is grass covered and the width is approximately 16 feet. The upstream face of the dam is on a slope of 2.75H:1V and is protected by riprap from the toe to 2.5 feet below the dam crest. The top 2.5 feet of the upstream face of the dam is grass covered. The downstream face of the dam is constructed on a slope of about 2.25H:1V and is grass covered.

The impervious core is composed of selected materials compacted in about one foot lifts. The core is centered about the longitudinal dam axis and has a bottom width equal to one-third of the dam base width. The core extends from two feet below existing ground level to 1.5 feet below the top of the dam and has a uniform top width of about 11 feet. The upstream and downstream shells consist of compacted earth.

A graded filter drain, located about 10 feet downstream of the core, extends the entire length of the dam. Water from the drain system is collected by two 6-inch diameter cast iron pipes which discharge near the downstream headwall for the outlet of the service spillway system and the outlet works.

The service spillway and outlet works are combined in a reinforced concrete intake tower constructed at the toe of the upstream slope near the center of the dam. The tower is accessible from the dam crest via a reinforced concrete bridge. The three-sided drop inlet spillway is constructed on the downstream side of the riser structure. The weir length is 12 feet and the elevation of the crest is about 8 feet below top of the dam. The spillway outlet conduit is a 42-inch diameter reinforced concrete pipe with anti-seep collars which extends through the embankment to a headwall 180 feet downstream of the riser structure.

The low-level outlet works consist of a gated 36-inch diameter reinforced concrete intake conduit, a three-chambered reinforced concrete gate structure, and a 16-inch diameter reinforced concrete outlet conduit. Two of the three intake chambers have gated 12-inch diameter cast iron intake pipes located at about mid-height of the intake tower. The gate configuration is such that discharge from the tower can be directed into the 42-inch diameter spillway outlet conduit or the 16-inch diameter outlet pipe. All gate valves are manually operated from the top of the intake tower. All discharges from the service spillway and intake tower are directed into the riprapped outlet channel.

The grass lined trapezoidal spillway and outlet channel is located at the left (east) abutment. The broad-crested weir is about 4 feet below top of dam, is 36 feet wide, 55 feet long and has 3H:1V side slopes. Discharge from the emergency spillway is directed down the east stream valley slope about 130 feet downstream of the dam.

c. Size Classification. B.E. Lockwood Dam has a maximum storage capacity of approximately 1291 acre-feet and a maximum height of 34 feet. The criteria for the "Intermediate" size category includes dams which have a storage capacity between 1,000 and 50,000 acre-feet. Therefore, B.E. Lockwood Dam is classified as an "Intermediate" size dam.

d. Hazard Classification. Bethlehem (Watertown) Reservoir Dam, located about 2,000 feet downstream of B.E. Lockwood Dam, would be overtopped by 6.1 feet and 5.0 feet as a result of the breaching of B.E. Lockwood Dam with the reservoir surface at the top of the dam and at the service spillway crest, respectively.

B.E. Lockwood Dam is located approximately 2.9 miles upstream of two single family dwellings. The first floor elevation of these homes is about 5 feet above the stream bed. Results of the dam breach analysis with the reservoir at the top of the dam indicate that the resulting depth of floodwaters would be about 2 feet above the first floor elevation of these structures. The dam is therefore classified as "High" hazard since a failure could cause excessive property damage and the possible loss of more than a few lives.

Refer to photos 9, 10, 11 & 12 in Appendix C.

e. Ownership. The dam is owned by the Watertown Fire District, 24 DeForest St., Watertown, CT, 06795. Telephone: 203-274-6332.

f. Operator. The dam is operated by Mr. Duane George, Assistant Superintendent, Water Division, Watertown Fire District, Telephone: 203-274-6332.

g. Purpose of Dam. The dam impounds water for the Watertown Fire District's water distribution system and also provides flood storage between the service spillway crest and the emergency spillway crest.

h. Design and Construction History. B.E. Lockwood Dam was designed by Malcolm Pirnie, Inc., 2 Corporate Park, White Plains, N.Y. 10602. The dam was completed in 1958. Drawings and hydraulic design data are available from Malcolm Pirnie, Inc. and DEP, respectively.

i. Normal Operating Procedures. The reservoir is normally self-regulating with the normal pool level slightly above the service spillway crest.

### 1.3 Pertinent Data

a. Drainage Area. The watershed for B.E. Lockwood Dam is 1.4 square miles in area and is predominantly forested with some open pastureland. A marsh of about 50 acres is located about 0.8 miles upstream of the dam.

#### b. Discharge at Damsite

1) Outlet Works. The outlet works consist of a 16-inch diameter reinforced concrete outlet conduit connected to the intake tower. The estimated discharge capacity is about 44 cfs with the reservoir level at the top of the dam.

2) Maximum Known Flood at Damsite. Weekly reservoir pool elevations are recorded. Maximum known stage in the reservoir was about 3 feet below the top of the dam.

3) Ungated Spillway Capacity at Top of Dam. The combined discharge capacity of the service and emergency spillways with the reservoir at the top of the dam Elev. 988.0 is 1241 cfs.

4) Ungated Spillway Capacity at Test Flood Elevation. The combined spillway capacity with the reservoir at the test flood Elev. 988.5 is about 1530 cfs.

5) Gated Spillway Capacity at Normal Pool Elevation. Not Applicable.

6) Gated Spillway Capacity at Test Flood Elevation. Not Applicable.

7) Total Spillway Capacity at Test Flood Elevation. Same as 4) above.

8) Total Project Discharge at Top of Dam. Same as 3) above.

9) Total Project Discharge at Test Flood Elevation. The combined discharge capacity of the spillway and the flow over the dam at test flood Elev. 988.5 is 2,595 cfs.

c. Elevation. (NGVD)

Streambed at Toe of Dam	954.0
Bottom of Cutoff	952.0 <sup>+</sup>
Maximum Tailwater	Unknown
Normal Pool	980.0
Full Flood Control Pool	984.0
Spillway Crest (Service and Emergency)	980.0; 984.0
Design Surge (Original Design)	Unknown
Top of Dam	988.0
Test Flood Surge	988.5

d. Reservoir Length. (feet)

Normal Pool	2,800
Flood Control Pool	2,900
Spillway Crest Pool	2,800
Top of Dam	3,050
Test Flood Pool	3,070

e. Storage. (Acre-feet)

Normal Pool	699
Flood Control Pool	980
Spillway Crest Pool	699
Top of Dam	1291
Test Flood Pool	1328

f. Reservoir Surface. (Acres)

Normal Pool	67
Flood Control Pool	74
Spillway Crest	67
Top of Dam	81
Test Flood Pool	82

g. Dam

Type	Compacted, zoned, earth embankment
Length	820 feet
Height	34 feet
Top Width	16 feet
Side Slopes (upstream)	2.75H:1V
(downstream)	2.25H:1V
Zoning	Rolled earth zones, refer to Appendix B
Impervious Core	Rolled, Selected impervious material
Cutoff	ave. 2 feet below ground surface, rolled impervious material
Grout Curtain	None

h. Diversion and Regulating Tunnel. None

i. Spillway.

Type (Service)	Sharp crested, drop-inlet, 42-inch diameter closed conduit
(Emergency)	Trapezoidal, broad-crested earth weir
Crest Length (Service)	12 feet
(Emergency)	36 feet
Crest Elevation (Service)	980.0
(Emergency)	984.0
Gates	None
Upstream Channel (Service)	None
(Emergency)	Grassed trapezoidal section
Downstream Channel (Service)	Riprapped stream channel
(Emergency)	Grassed trapezoidal section, valley slope & Stream channel

j. Regulating Outlets. Hand operated gate valves control discharge into and out of the intake tower. The invert elevation of the low-level 36-inch diameter intake conduit is about 951.0. The invert elevation of the 16-inch diameter outlet conduit is about 948.0 at the intake tower and 946.5 at the downstream headwall.

## SECTION 2

### ENGINEERING DATA

#### 2.1 Design

The following set of design plans, dated April 1958, were made available by Malcolm Pirnie, Inc. for review of B.E. Lockwood Dam:

- Sheet 1, General Plan and Sections
- Sheet 2, Section of Dam
- Sheet 3, Diversion and Intake, Plans and Sections
- Sheet 4, Outlet Structure and Details

The design report for the structure prepared by Malcolm Pirnie, Inc. was provided by DEP. The principal design features for this dam are shown on the drawings and design report enclosed in Appendix B.

#### 2.2 Construction

According to the Owner's representative, information is not available concerning the construction of B.E. Lockwood Dam.

#### 2.3 Operation

According to the Owner's representative, weekly reservoir pool elevations are maintained by the Watertown Fire District.

#### 2.4 Evaluation

a. Availability. Malcolm Pirnie, Inc. provided design drawings for the structure. The design report for the structure prepared by Malcolm Pirnie, Inc. was made available by DEP.

b. Adequacy. The design drawings and design report together with conversations with the Owner's representative and the visual inspection data are adequate for a Phase I investigation.

c. Validity. The data obtained for this site is in conformance with the field measurements.

## SECTION 3

### VISUAL INSPECTION

#### 3.1 Findings

a. General. The field inspection of B.E. Lockwood Dam was performed on November 20, 1979. At the time of inspection, the reservoir water surface was about 2.5 feet below the service spillway crest. No underwater areas were inspected.

The observations and comments of the field inspection team are in the checklist which is Appendix A of this report.

b. Dam. The dam is considered to be in good condition. There was no evidence of slope or crest misalignments, sloughing, crest undulations, riprap failures or seepage noted during the visual inspection. The embankment crest and slopes are covered with short grass. The riprap on the upstream slope consists of angular cobbles and small boulders. Several small trees (2 to 3-inch diameter trunks) are growing on the upstream slope near the right abutment (Page C-1). A clear discharge of less than 0.1 gpm was observed flowing from each of the two outlets for the internal drainage system (Page C-3). Small asphalt paved drainage ditches which discharge into the outlet channel are located immediately downstream of the embankment along both abutments (Page C-4).

c. Appurtenant Structures. The drop-inlet closed conduit service spillway which is provided with a trash screen is in good condition and was clear of debris at the time of inspection (Page C-2). The reinforced concrete bridge and intake tower appears to be structurally sound. The pipe railing and valve stands appear to have been recently painted. According to the Owner's representative, all valves are operable and the operating wheels were in place at time of inspection. The concrete head wall for the 36-inch diameter spillway outlet conduit and 16-inch diameter low level outlet conduit is in good condition. A 3-inch depth of water estimated at about 1 cfs was discharging from the 36-inch diameter service spillway outlet pipe (Page C-2).

The trapezoidal emergency spillway and outlet channel are grasslined. The upstream approach to the emergency spillway contained standing water at the time of inspection although the reservoir pool was nearly 4 feet below the channel invert (Page C-4). Brush and marshy vegetation are also growing in this area (Page C-1).

d. Reservoir Area. The terrain along the perimeter of the reservoir is wooded with apparently stable slopes which vary between 2 and 20 percent.

e. Downstream Channel. The channel downstream of the outlet conduits is lined with riprap for about 60 feet. About 1,000 feet downstream of B.E. Lockwood Dam, the channel discharges into the headwaters of the Bethlehem (Watertown) Reservoir. The channel between B.E. Lockwood Dam and Bethlehem Reservoir is about 10 feet wide, has approximately 3H:1V side slopes and has a gradient estimated to be one percent.

### 3.2 Evaluation

The dam is considered to be in good condition. The heavy vegetation growing in the emergency spillway approach channel reduces the discharge capacity of the spillway system. The root systems of the small trees growing on the upstream slope may eventually displace the riprap exposing the embankment to hydraulic erosion. The service spillway and intake tower appear to be in good condition.

SECTION 4  
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. According to Mr. Duane George, the Owner's representative, a minimum discharge of about one cfs is maintained in East Spring Brook through the 36-inch diameter service spillway outlet conduit. Reservoir stage recordings made on a weekly basis are currently maintained by the Owners.

b. Description of Any Warning System in Effect. According to Mr. George, no formal flood warning system is in effect at B.E. Lockwood Dam; however, downstream residents would be warned by phone in the event of flooding in East Spring Brook by personnel of the Watertown Fire District.

4.2 Maintenance Procedures

a. General. According to Mr. George, the structure is inspected on a monthly basis. The grass on the entire embankment, emergency spillway channel slopes and the immediate downstream area of the dam is cut on a regular basis during the growing season. Debris is cleared from the spillways on a regular basis.

b. Operating Facilities. According to Mr. George, all gate valves are inspected semi-annually and are repaired as necessary.

4.3 Evaluation

The operational procedures and maintenance program for B.E. Lockwood Dam are considered to be adequate.



## SECTION 5

### EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

#### 5.1 General

B.E. Lockwood Dam has an elongated watershed of 1.4 square miles which is about 2 miles long and 0.7 miles wide. The drainage area, which is nearly equally divided between the towns of Bethlehem and Morris, is wooded with some open pastureland. A large marsh about one mile long and 0.15 miles wide is situated within the basin. The topography ranges from Elev. 1150 to Elev. 980 at the normal reservoir surface. Development in the drainage area consists of a few farms and the small village of Morris.

#### 5.2 Design Data

Hydraulic and hydrologic design data are available in the design report prepared by Malcolm Pirnie, Inc. and provided by DEP.

#### 5.3 Experience Data

There are no records of the dam overtopping at this site. According to the Owner's representative, the emergency spillway has operated at least twice with depths of flow up to about 1-foot. However, operating personnel were not on-site during these events, which occurred after regular working hours. The recorded reservoir pool levels indicated reservoir elevations of only a few inches above the emergency spillway crest elevation.

#### 5.4 Test Flood Analysis

The recommended test flood for an "Intermediate" size, "High" hazard dam is the full Probable Maximum Flood (PMF).

Hydrologic and hydraulic calculations were performed with the assistance of the HEC-1-DB computer program. The flood hydrographs were constructed from the Snyder unit hydrographs using average coefficients, an initial infiltration of zero and a constant loss rate of 0.05 inches per hour. The Hop Brook Adjustment Factor was used to reduce the Probable Maximum Precipitation based on the drainage area. Stage vs. discharge and stage vs. storage relationships were developed. The routing sequence consisted of routing the inflow hydrograph through the reservoir. B.E. Lockwood Reservoir was assumed to be at the service spillway crest elevation at the beginning of the storm event.

The test flood peak inflow to B.E. Lockwood Dam was computed as 2,930 cfs. The routed test flood outflow of 2,590 cfs overtops the dam by 0.5 feet which corresponds to a stage of 4.5 feet above the emergency spillway crest. The combined spillway system is capable of discharging 1,240 cfs prior to overtopping of the embankment, which is about 48 percent of the routed test flood outflow.

The routed outflow for one half of the PMF is 670 cfs which would peak at a level 1.6 feet below the crest of the dam.

It is also noted that a flood equivalent to 76 percent of the PMF could be routed through the dam without overtopping the dam.

### 5.5 Dam Failure Analysis

A failure of the embankment was simulated by the HEC-1-DB computer program assuming a 124 feet wide and 28 feet deep breach with vertical side slopes developing within one hour. Failures are assumed to occur with the reservoir surface at the top of dam and at the service spillway crest. The resulting outflows of 15190 cfs and 9040 cfs, with the reservoir surface at the top of the dam and at the service spillway crest, respectively, were routed through Bethlehem (Watertown) Reservoir to the damage center, which is assumed to be two private dwellings about 2.9 miles downstream of the dam. Bethlehem Reservoir Dam would be overtopped by 5.0 feet and 6.1 feet for the two above discussed conditions, respectively. Discharges at the damage center prior to breaching of the dam were 945 cfs (2.7-foot depth of flow) and 50 cfs (0.5-foot depth of flow) for the two conditions, respectively. The channel cross-section used in the breach analysis for the hazard area was obtained from the USGS quadrangle entitled "Woodbury, Conn." and is shown on Page D-8. The stream depth at this point was computed to be 7.0 feet or 4.0 feet above the channel banks with the reservoir surface at the service spillway crest. For the failure with the reservoir surface at the top of the dam, at least 2 feet of water would be in the first floor of the homes at the damage center. Excessive property damage and possible loss of more than a few lives could occur.

## SECTION 6

### STRUCTURAL STABILITY

#### 6.1 Visual Observations

The root systems of the small trees growing on the upstream face of the dam near the right abutment could eventually displace the riprap exposing the embankment to erosion. The heavy vegetation growing in the emergency spillway approach channel reduces the discharge capacity of the spillway system.

#### 6.2 Design and Construction Data

No information is available concerning stability analyses, seepage computations, or embankment and foundation material properties.

#### 6.3 Post Construction Changes

According to the Owner's representative, no post construction changes have been made at this site.

#### 6.4 Seismic Stability

B.E. Lockwood Dam is located in Seismic Risk Zone 1 on the "Seismic Zone Map of Contiguous States." A dam located in Seismic Zone 1 need not be evaluated for seismic stability, according to the Recommended Guidelines for Phase I Dam Inspections.

## SECTION 7

### ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

#### 7.1 Dam Assessment

a. Condition. The visual observations and review of the available information indicate that B.E. Lockwood Dam is in good condition. The roots of small trees growing on the upstream face of the dam may eventually displace the riprap exposing the embankment to wave action and erosion. The heavy vegetation growing in the emergency spillway approach channel reduces the discharge capacity of the spillway system.

b. Adequacy of Information. The design drawings provided by Malcolm Pirnie, Inc. and the design report prepared by Malcolm Pirnie, Inc. and provided by DEP together with conversations with the Owner's representative and the visual inspection data are adequate for a Phase I investigation.

c. Urgency. The remedial measures covered in this Section of the report should be implemented within 2 years from the date of receipt of this Phase I Inspection Report.

#### 7.2 Recommendations

No recommendations are offered.

#### 7.3 Remedial Measures

##### a. Operation and Maintenance Procedures.

1. The small trees growing on the upstream face of the dam should be removed.

2. The heavy vegetation should be cut in the approach channel of the emergency spillway. This area should also be graded to permit proper drainage.

3. A formal surveillance and flood warning plan, including round-the-clock monitoring during heavy precipitation, should be developed.

4. Institute a program of biennial technical inspection.

#### 7.4 Alternatives

No valid alternatives to the recommendations described above are considered feasible for this site.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST  
INSPECTION TEAM ORGANIZATION

Project: Bronson E. Lockwood Dam  
National I.D. #: CT 00435  
Location: Bethlehem, Connecticut  
Type of Dam: Compacted, zoned, earth embankment  
Inspection Date(s): November 20, 1979  
Weather: Clear, warm, mid '50's  
Pool Elevation: 977.5 ± MSL

Inspection Team

Leonard Beck	O'Brien & Gere	Structures
Steven Snider	O'Brien & Gere	Foundations & Materials
Alan Hanscom	O'Brien & Gere	Structures
Rodney Georges	Bryant & Associates	Hydrology/Hydraulics

\*Mr. John J. Williams, Vice-President, O'Brien & Gere has visited the site but not necessarily in conjunction with the inspection team.

Owner's Representative

Mr. Duane George, Assistant Superintendent,

Water Division, Watertown Fire Department

# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	988.0
Current Pool Elevation	977.5 ±
Maximum Impoundment to Date	985.0 ±
Surface Cracks	None observed
Pavement Condition	Not applicable
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	No vertical misalignment observed
Horizontal Alignment	No horizontal misalignment observed
Condition at Abutment and at Concrete Structures	Satisfactory, no settlement or erosion observed.
Indications of Movements of Structural Items on Slopes	None observed.
Trespassing on Slopes	No paths have been worn on the slopes.
Vegetation on Slopes	Good upstream, downstream & crest
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	Few small trees growing between riprap stones on upstream face

# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT (Con't)</u>	
Unusual Movement or Cracking at or near Toes	<i>None observed</i>
Unusual Embankment or Downstream Seepage	<i>None observed</i>
Piping or Boils	<i>None observed</i>
Foundation Drainage Features	<i>Longitudinal filter drain in downstream portion of dam from abutment to abutment outlets parallel to service spillway</i>
Toe Drains	
Instrumentation System	
	<i>Not applicable</i>



# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
<p>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</p> <p><u>AUXILIARY SPILLWAY</u></p> <p>a. Approach Channel</p> <p>General Condition</p> <p>Loose Rock Overhanging Channel</p> <p>Trees Overhanging Channel</p> <p>Floor of Approach Channel</p> <p>b. Weir and Training Walls</p> <p>General Condition of Concrete</p> <p>Rust or Staining</p> <p>Spalling</p> <p>Any Visible Reinforcing</p> <p>Any Seepage or Efflorescence</p> <p>Drain Holes</p> <p>c. Discharge Channel</p> <p>General Condition</p>	<p>Heavy vegetation, standing water</p> <p>None observed</p> <p>None observed</p> <p>Several pools of standing water needs drainage</p> <p>Not applicable</p> <p>Weir section is 36 feet wide, 55 feet long, has 3H:1V side slopes and it is 4 feet below the crest of the dam.</p> <p>Good condition with vegetative cover recently cut, no bare spots</p>

# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS (Con't)	
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	None observed
Floor of Channel	completely covered with close cut grass.
Other Obstructions	None observed
A-5	

# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
<u>OUTLET WORKS - CONTROL TOWER</u>	
a. Concrete and Structural	
General Condition	<i>Good</i>
Condition of Joints	<i>No problems</i>
Spalling	<i>None observed</i>
Visible Reinforcing	<i>None observed</i>
Rusting or Staining of Concrete	<i>None observed</i>
Any Seepage or Efflorescence	<i>None observed</i>
Joint Alignment	<i>No misalignment observed</i>
Unusual Seepage or Leaks in Gate Chamber	<i>None observed</i>
Cracks	<i>None observed</i>
Rusting or Corrosion of Steel	<i>None observed</i>
b. Mechanical and Electrical	
Air Vents	<i>Not applicable</i>
Float Wells	
Crane Hoist	

# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
<u>OUTLET WORKS - CONTROL TOWER (Con't)</u>	
Elevator	<i>Not applicable</i>
Hydraulic System	<i>Not applicable</i>
Service Gates	<i>All gates are inspected twice annually &amp; repaired as needed, were not observed, below water.</i>
Emergency Gates	
Lighting Protection System	<i>Not applicable</i>
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
<u>OUTLET WORKS - SERVICE BRIDGE</u>	
a. Super Structure	
Bearings	Good condition
Anchor Bolts	Not applicable
Bridge Seat	Not applicable
Longitudinal Members	Good condition
Under Side of Deck	Good condition
Secondary Bracing	Good condition
Deck	Good condition
Drainage System	Not applicable
Railings	Good condition recently painted
Expansion Joints	Not applicable
Paint	Good recently applied
b. Abutment & Piers	
General Condition of Concrete	Good
Alignment of Abutment	True

# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
<p><u>OUTLET WORKS - SERVICE BRIDGE (Con't)</u></p> <p>Approach to Bridge</p> <p>Condition of Seat &amp; Backwall</p>	<p><i>No obstructions</i></p> <p><i>Good</i></p>

# VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	<i>Good</i>
Rust or Staining on Concrete	<i>None observed</i>
Spalling	<i>None observed</i>
Erosion or Cavitation	<i>None observed</i>
Cracking	<i>None observed</i>
Alignment of Monoliths	<i>No misalignment observed</i>
Alignment of Joints	

VISUAL INSPECTION CHECK LIST

Project: Bronson E. Lockwood Dam

National I.D. #: CT 00435

Date(s): Nov. 20, 1979

AREA EVALUATED	CONDITIONS
<p><u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u></p> <p>General Condition of Concrete</p> <p>Rust or Staining</p> <p>Spalling</p> <p>Erosion or Cavitation</p> <p>Visible Reinforcing</p> <p>Any Seepage or Efflorescence</p> <p>Condition at Joints</p> <p>Drain Holes</p> <p>Channel</p> <p>Loose Rock or Trees Overhanging Channel</p> <p>Condition of Discharge Channel</p>	<p><i>Good</i></p> <p><i>None observed</i></p> <p><i>None observed</i></p> <p><i>None observed</i></p> <p><i>None observed</i></p> <p><i>None observed</i></p> <p><i>Good</i></p> <p><i>No obstructions</i></p> <p><i>Some marsh grasses</i></p> <p><i>None observed</i></p> <p><i>Good except for some marsh grasses</i></p>



APPENDIX B  
ENGINEERING DATA

SUBJECT	SHEET	BY	DATE	JOB NO
BRONSON E. LOCKWOOD DAM				

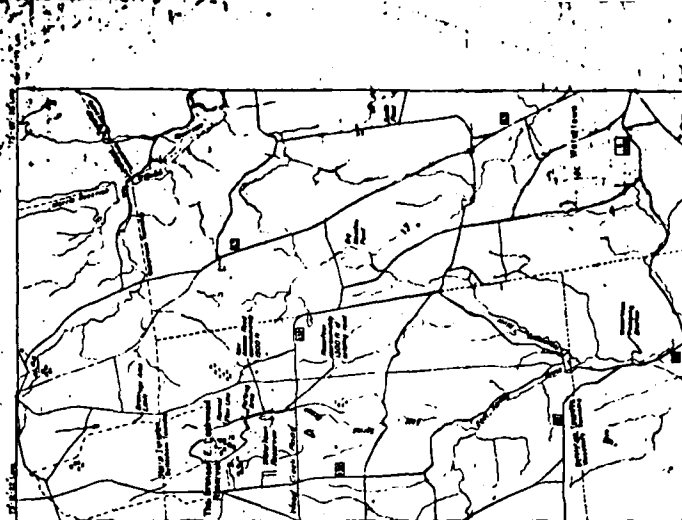
APPENDIX B  
ENGINEERING DATA  
TABLE OF CONTENTS

GENERAL PLAN & SECTIONS  
SECTIONS OF DAM  
DIVERSION & INTAKE PLANS & SECTIONS  
DESIGN REPORT

PAGE  
B-1  
B-2  
B-3  
B-4  
thru  
B-12

B-1

SHEET 1 OF 2



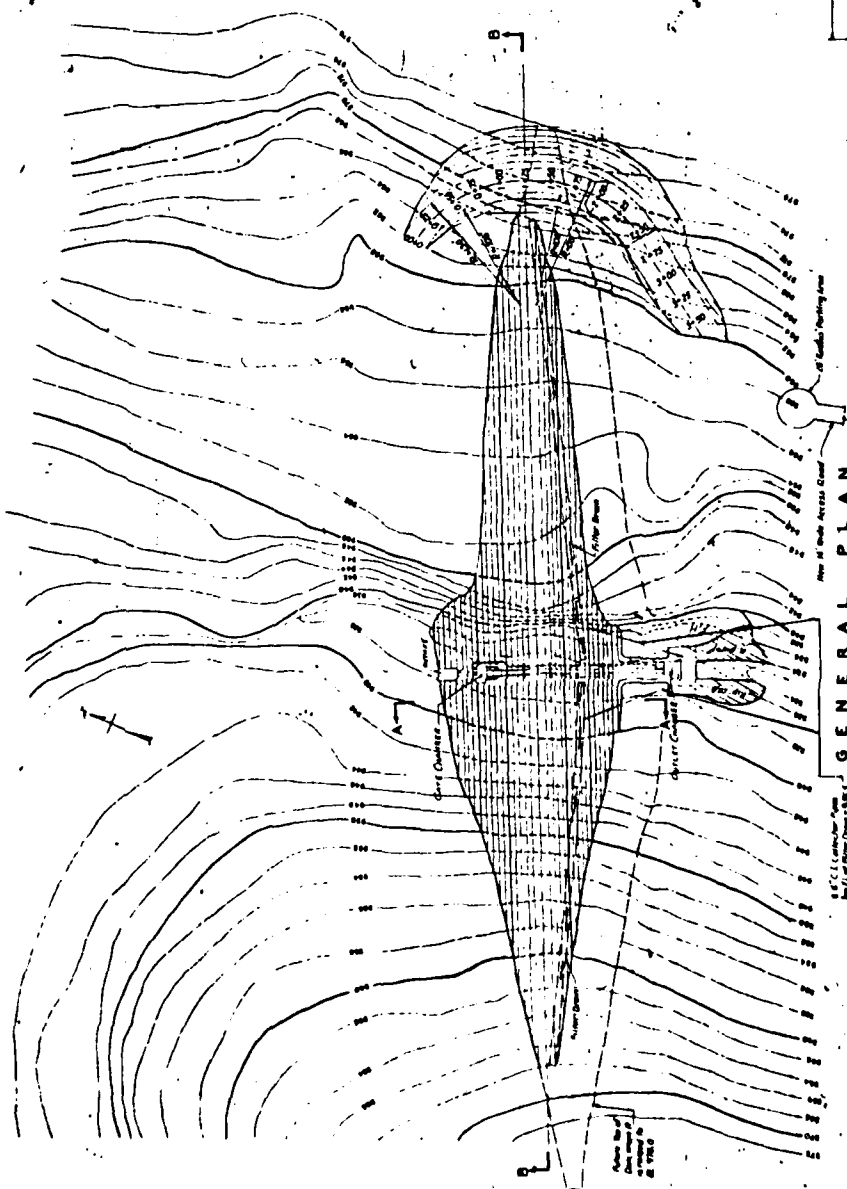
LOCATION PLAN  
SCALE 1"=100'



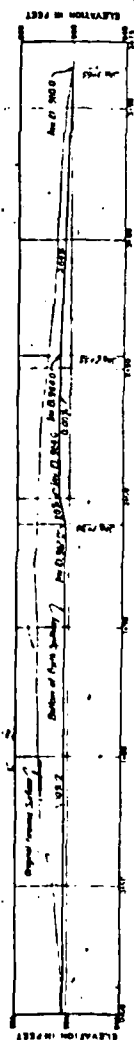
SECTION ALONG CENTERLINE OF INTAKE STRUCTURE  
SCALE 1"=20'

FOR INFORMATION USE ONLY  
NOT TO BE USED FOR CONSTRUCTION

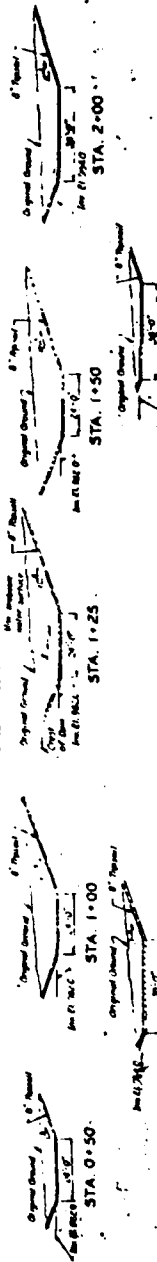
WATERTOWN, CONN.  
THE BRONSON E. LOCKWOOD RESERVOIR  
GENERAL PLAN AND SECTIONS  
SCALE AS NOTED



GENERAL PLAN  
SCALE 1"=500'



PROFILE ALONG CENTERLINE OF EARTH SPILLWAY  
SCALE 1"=20'



CROSS SECTIONS ALONG EARTH SPILLWAY  
SCALE 1"=20'

STA. 0+50

STA. 1+00

STA. 1+25

STA. 1+50

STA. 3+00

STA. 2+00

STA. 1+00

STA. 0+50

STA. 0+00

STA. 0+50

STA. 1+00

STA. 1+50

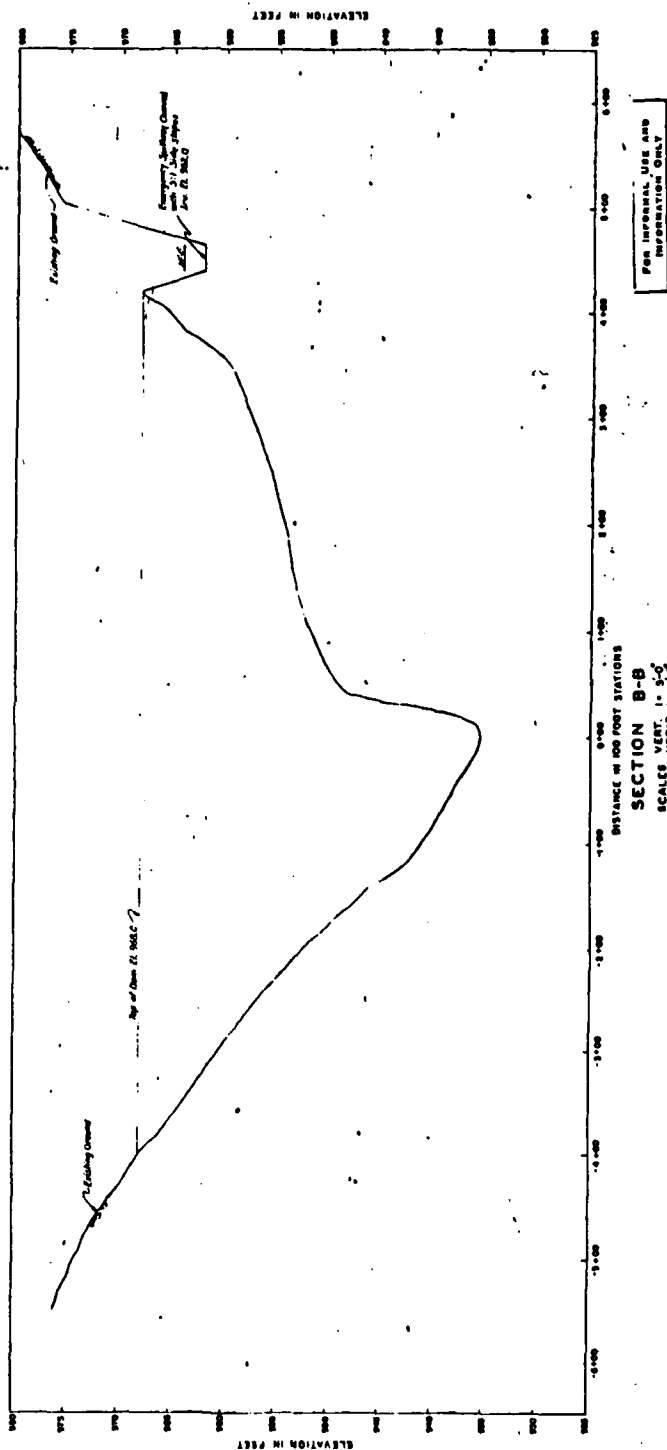
STA. 2+00

STA. 2+50

STA. 3+00

[illegible]

0-20  
DISTANCE IN 100 FOOT STATIONS  
SECTION A-A  
SCALE 1/8"=1'-0"



SECTION B-B  
SCALE VERT. 1" = 5'-0"  
HORIZ. 1" = 50'-0"

FOR INTERNAL USE AND  
CIRCULATION ONLY

WATERTOWN, CONN.  
THE BRONSON E. LOCKWOOD RESERVOIR  
SECTIONS OF DAM.  
SCALES AS NOTED

ALL (numbers) refer to  
Reference Book Number

**QUALCOMM POWER ENGINEERING**  
**11000 JEFFERSON ST. SUITE 100**



B-4

WATERTOWN FIRE DISTRICT  
WATERTOWN, CONNECTICUT

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DESIGN REPORT  
BRONSON E. LOCKWOOD RESERVOIR

---

APRIL 1958

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Location

The Bronson E. Lockwood Reservoir, proposed by the Watertown Fire District, is located on East Spring Brook about one-mile north of Route 132 in Bethlehem Township. The location is shown on Sheet 1 of 4 of the contract drawings.

Description of Project

The river has a drainage area of about 1.5 square miles above the dam site. The proposed dam will have a spillway of Elevation 960 and will impound a reservoir of 290 million gallons practically all of which is usable. The dam will be constructed so that it will be possible to raise the spillway to Elevation 968 in the future. Area capacity curves for the site are shown in Figure 1.

The Watertown Fire District at present obtains its water from the Hart's Farm Well Field adjacent to the

B-5

Nonewaug River. The wells are inadequate during dry periods and it is necessary to purchase water from Waterbury.

Using the Bronson E. Lockwood Reservoir for discharge during low flows, it will be possible to maintain a dependable flow of about 2 mgd in the Nonewaug River at Hart's Farm. It is estimated that utilization of this flow by a low diversion dam and recharge basin will provide a dependable yield of at least 1.2 mgd from the well field.

A dam with a spillway at Elevation 968 will impound sufficient water to maintain a dependable flow of 3.0 mgd at Hart's Farm.

The piping arrangement of the Bronson E. Lockwood Dam is such that it will be possible to pipe water directly to Watertown by gravity at some future time.

The dam is to be an earth dam with a drop inlet spillway and an emergency earth spillway. The crest of the emergency spillway will be 4 feet above the drop inlet spillway and the top of the dam will be 4 feet above the emergency spillway.

#### Flood Flows

There is no record of stream flow gagings on East Spring Brook or the Nonewaug River.

B-6

Peak flows at the dam site have been estimated by the procedure outlined in Geological Survey Circular 365 as modified in the Connecticut Society of Civil Engineers 73rd Annual Report, Page 89 and 92. Peak floods and flood hydrographs were also calculated according to procedures outlined in the Soil Conservation Service, Engineering Handbook, Hydrology Supplement A, Section 4.

Judging the drainage area to have normal characteristics in accordance with Circular 365 nomenclature, the mean annual flood was estimated to be 100 cfs. Peak flows for other frequencies were estimated as shown in Table 1.

Table 1

<u>Recurrence Interval Years</u>	<u>Peak Flow cfs</u>	<u>Recurrence Interval Years</u>	<u>Peak Flow cfs</u>
5	130	100	360
10	160	200	450
15	185	300	500
20	205	500	600
50	285	1,000	770

A hundred-year flood hydrograph as estimated by the Soil Conservation Service method is shown in Figure 3. The peak flow is 565 cfs as compared to 360 cfs by the method used in Circular 365.

The flood hydrograph resulting from the maximum probable six-hour storm on the drainage area was also constructed by



B-7

the Soil Conservation Service method. This hydrograph which has a peak flow of 1,850 cfs is shown in Figure 4.

#### Flood Routing

The rating curve for the spillway structures is shown in Figure 2.

The flow for the first 3 feet of water depth over the spillway has been estimated as weir flow. Approximately at a 3-foot depth the drop inlet is primed and the capacity of the unit is a function of the difference in elevation between tail water and the reservoir water surface. At a depth of 4 feet water starts flowing over the emergency earth spillway. The rating curve above this elevation includes both the flow through the drop inlet structure and over the earth spillway which acts as a broad crested weir. The capacity of the earth spillway has been estimated according to procedures outlined in the Soil Conservation Service Technical Release No. 2, October 1, 1956, entitled "Earth Spillways".

Both the 100-year and maximum probable flood were routed through the reservoir as shown on Figure 3 and Figure 4.

The drop inlet spillway which consists of a 4' x 4' drop inlet and a 42-inch pipe through the dam was sized to permit passage of the 100-year flood without use of the emergency spillway.

The emergency spillway was sized to permit passage of the maximum probable flood with the reservoir water surface 2 feet below the top of the dam. A trapezoidal section with a 36-foot bottom width was used.

Because of the physical nature of the reservoir site an exceptionally conservative hydraulic design is possible with very little increase in cost.

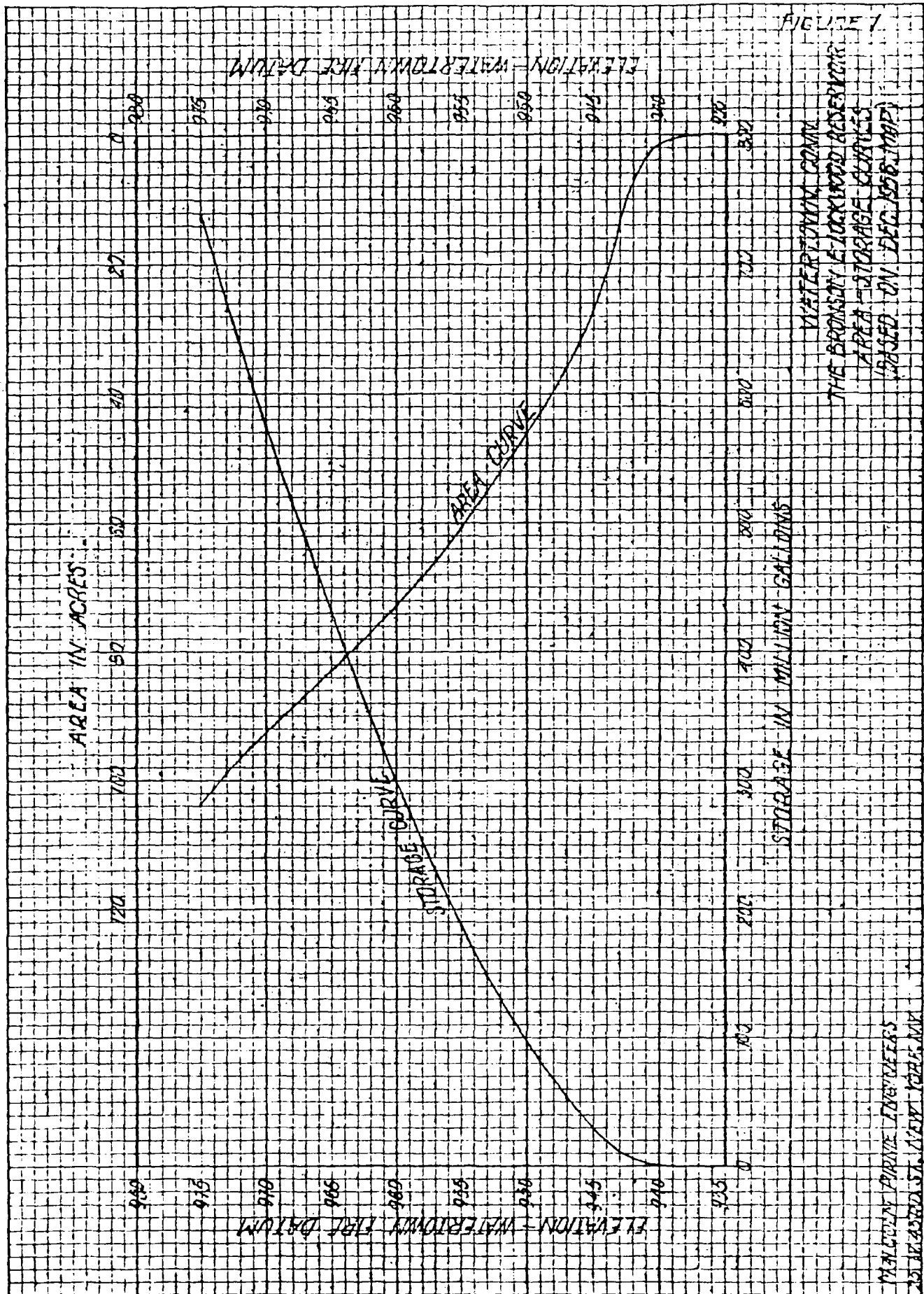
#### Plans and Specifications

The contract drawings consist of four (4) sheets which show plans, sections, elevations and details of gate chamber, concrete spillway and overflow structures. The dam will be a compacted earth dam. Suitable material exists in the reservoir area immediately above the dam.

It is planned to have full-time engineering supervision during the construction of the dam, control of moisture content, degree of compaction and density of compacted embankment will be maintained.

MALCOLM PIRNIE ENGINEERS

FIGURE 1



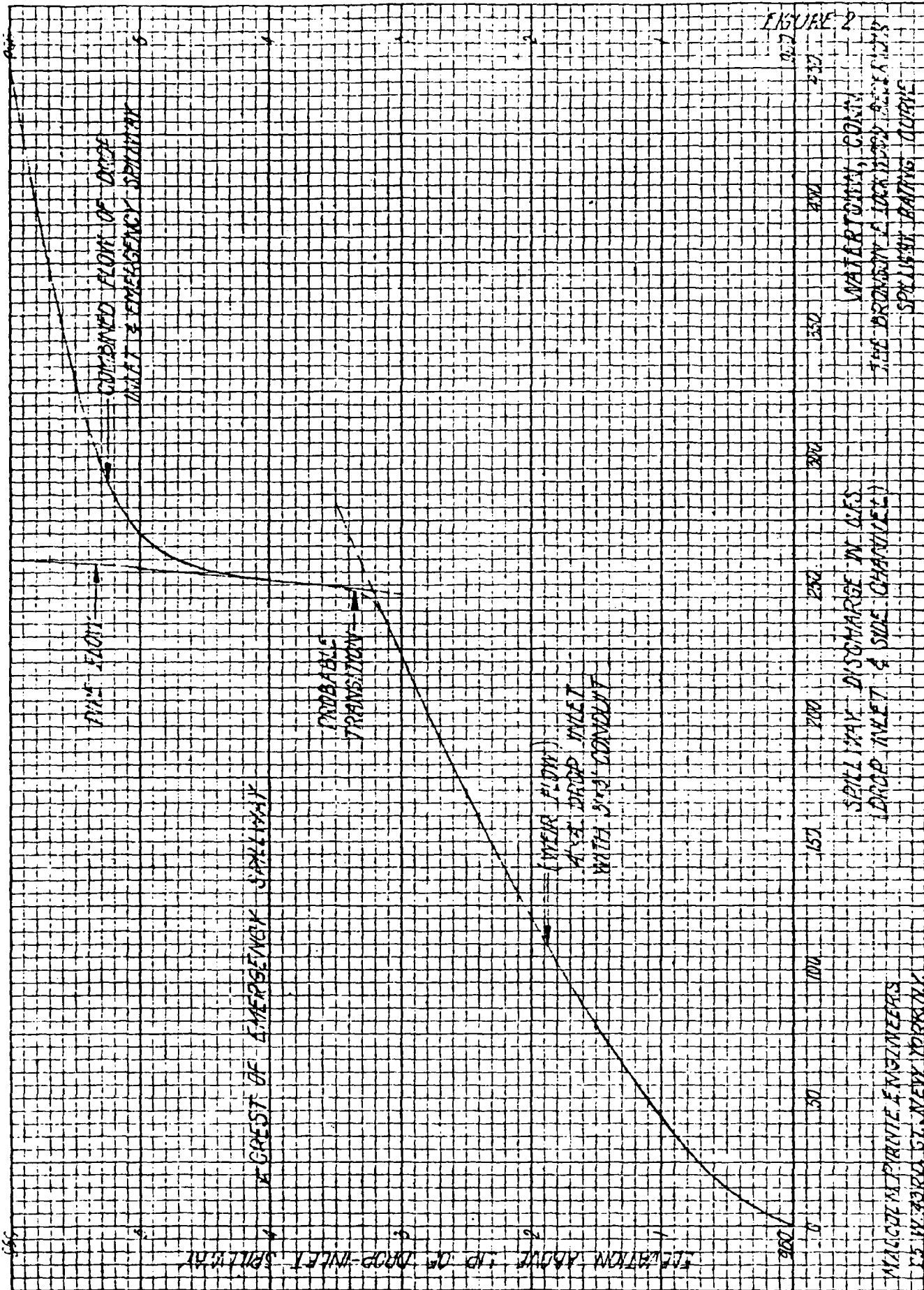
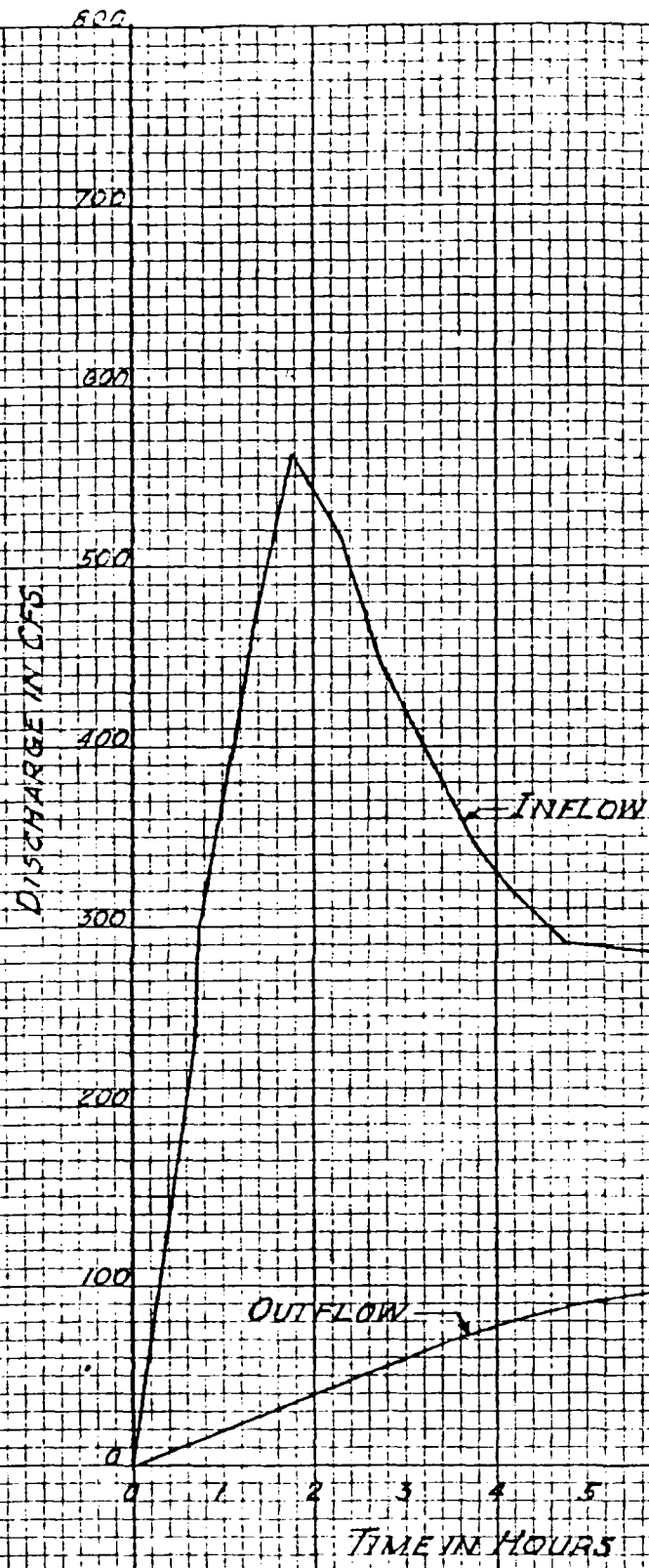


FIGURE 3

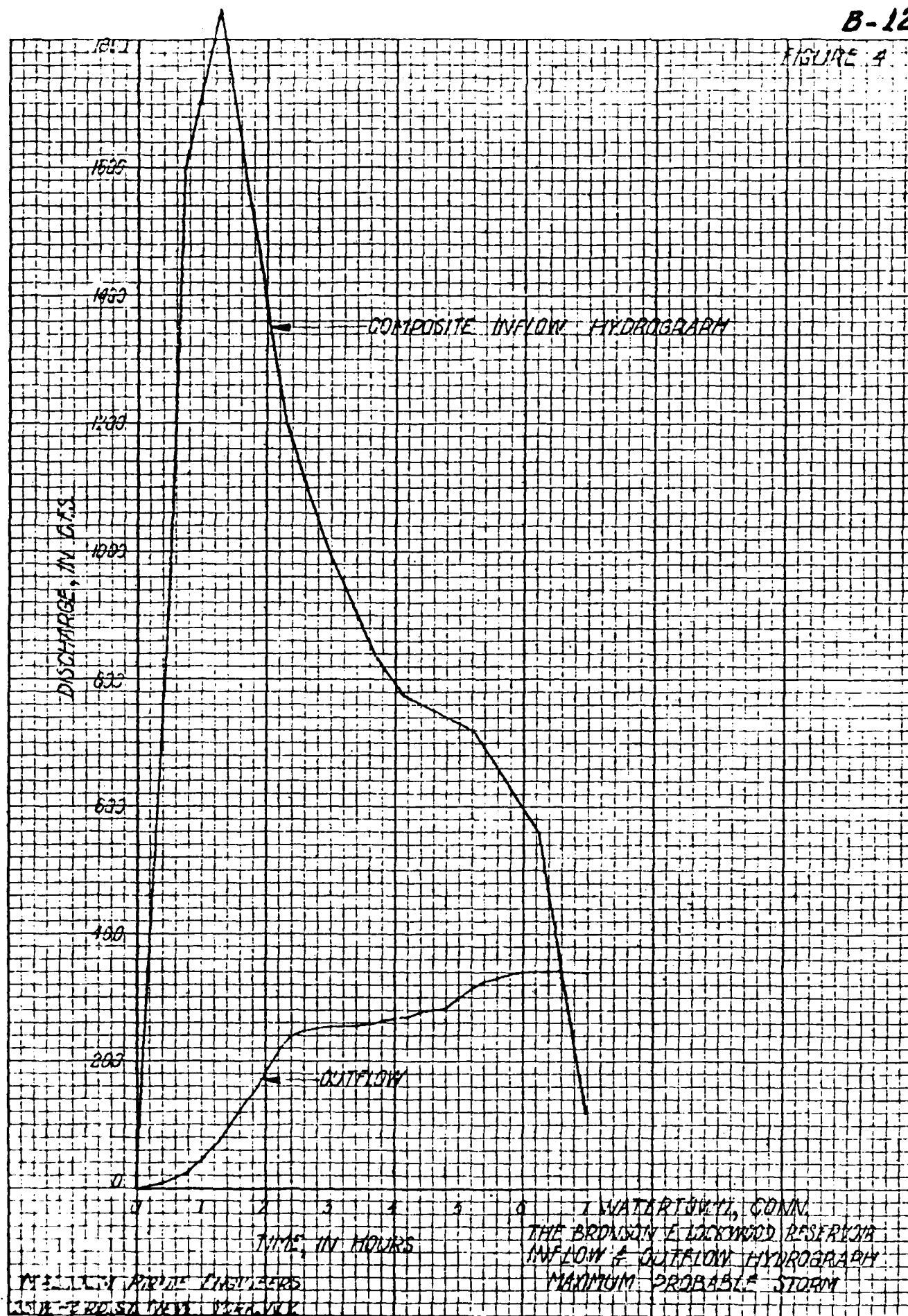


WATERTOWN, CONN.  
 THE BRONSON E. LOCKWOOD RESERVOIR  
 INFLOW & OUTFLOW HYDROGRAPHS  
 100 YEAR STORM

MALCOLM PIRNIE ENGINEERS  
 25 W. 43RD ST. NEW YORK, N.Y.

10 X 10 to the inch.  
 MADE IN U.S.A.

FIGURE 4



APPENDIX C  
PHOTOGRAPHS

APPENDIX C  
SELECTED PHOTOGRAPHS OF PROJECT

<u>LOCATION PLAN</u>	<u>Page No.</u>
Site Plan Sketch	A
Regional Plan	A
<u>PHOTOGRAPHS</u>	<u>Page No.</u>
<u>No.</u>	
1. Upstream face of the dam as viewed from the right abutment showing vegetation growing through the riprap.	1
2. Crest and upstream face of the dam in the vicinity of the entrance to the emergency spillway.	1
3. Principal spillway intake structure and catwalk.	2
4. Principal spillway impact basin outlet structure and outlet channel.	2
5. One of the two outlets for the internal drainage system of the dam.	3
6. Overview of the emergency spillway built into the left abutment of the dam.	3
7. Paved drainage way immediately downstream of the dam.	4
8. Standing water in the invert of the emergency spillway.	4
9. Spillway for the Bethlehem Reservoir Dam 1,800 feet downstream of Lockwood Dam.	5
10. Downstream overview of Bethlehem Reservoir Dam.	5
11. Potential hazard site about 3 miles downstream of the dam.	6
12. Potential hazard site about 3.5 miles downstream of the dam.	6



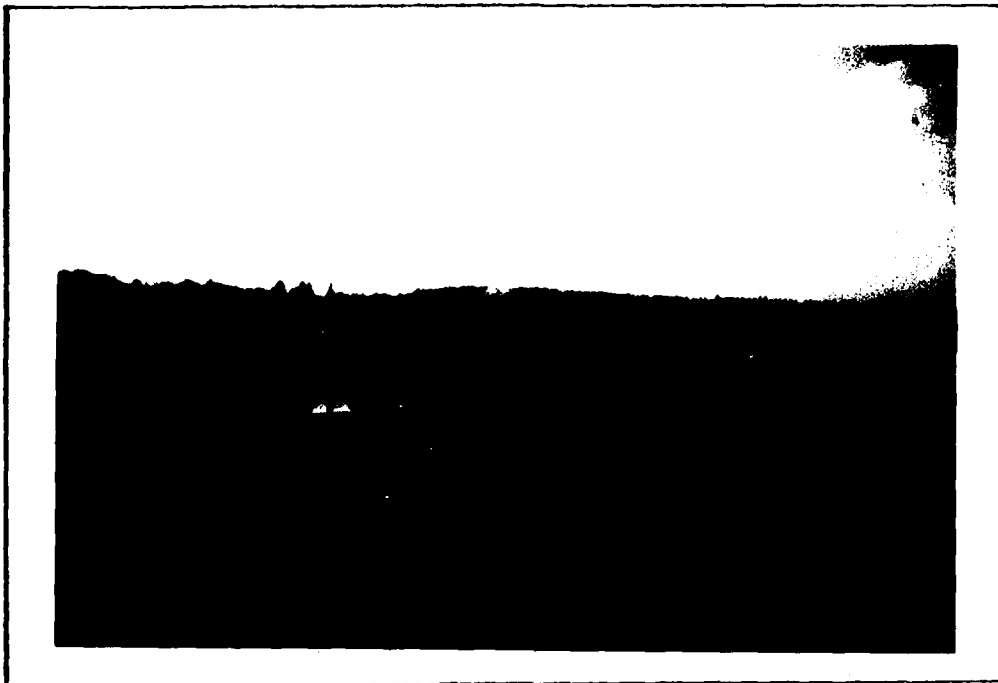




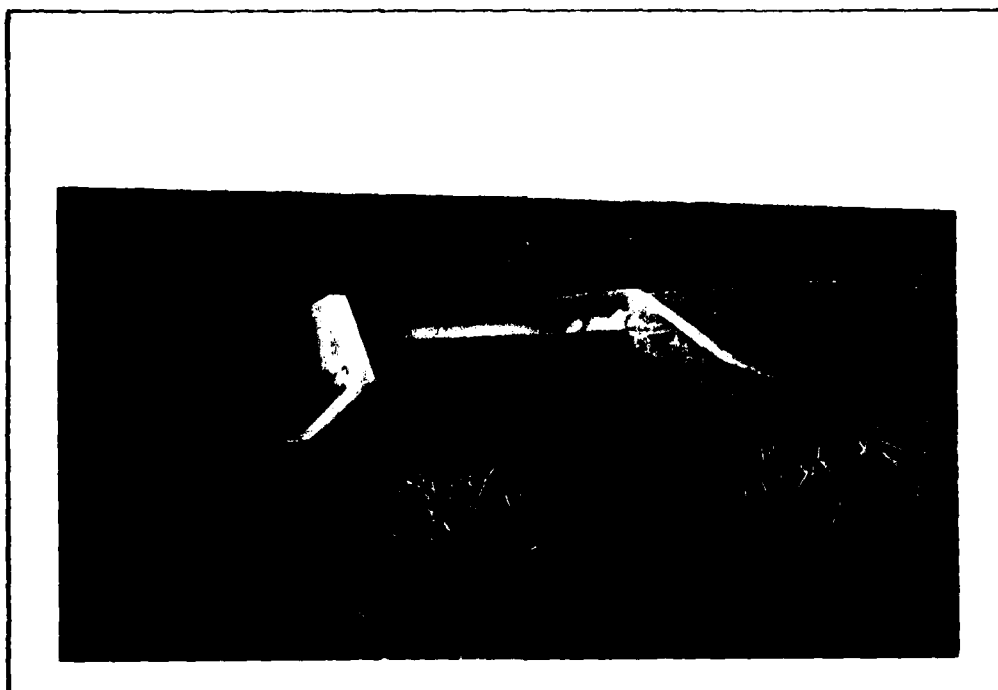
1. UPSTREAM FACE OF THE DAM AS VIEWED FROM THE RIGHT ABUTMENT SHOWING VEGETATION GROWING THROUGH THE RIPRAP. (11/20/79)



2. CREST AND UPSTREAM FACE OF THE DAM IN THE VICINITY OF THE ENTRANCE TO THE EMERGENCY SPILLWAY. (11/20/79)



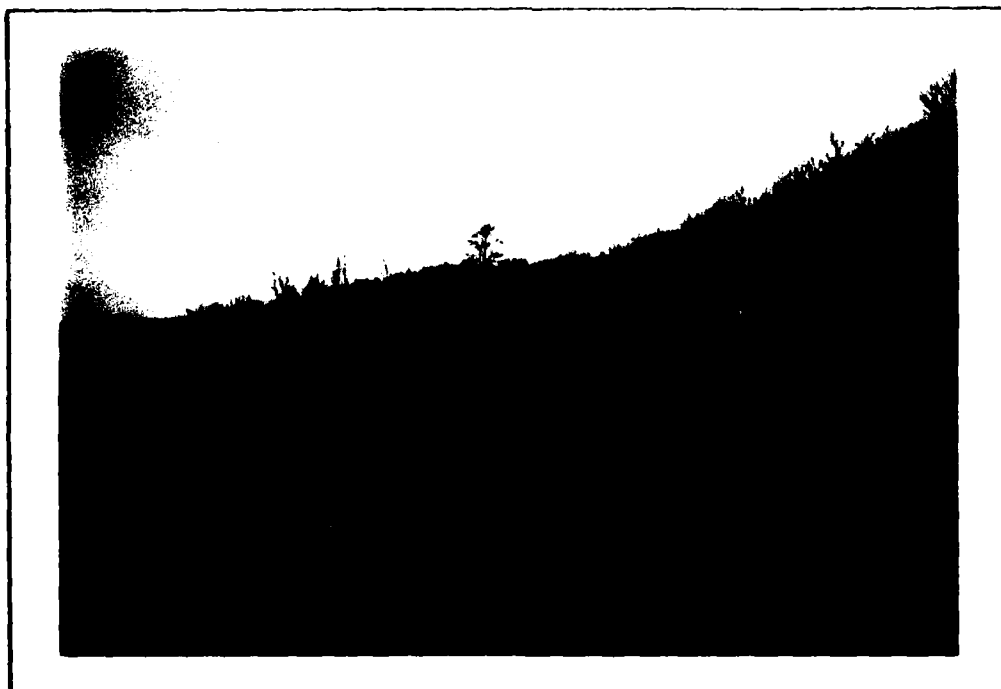
3. PRINCIPAL SPILLWAY INTAKE STRUCTURE AND CATWALK.  
(11/20/79)



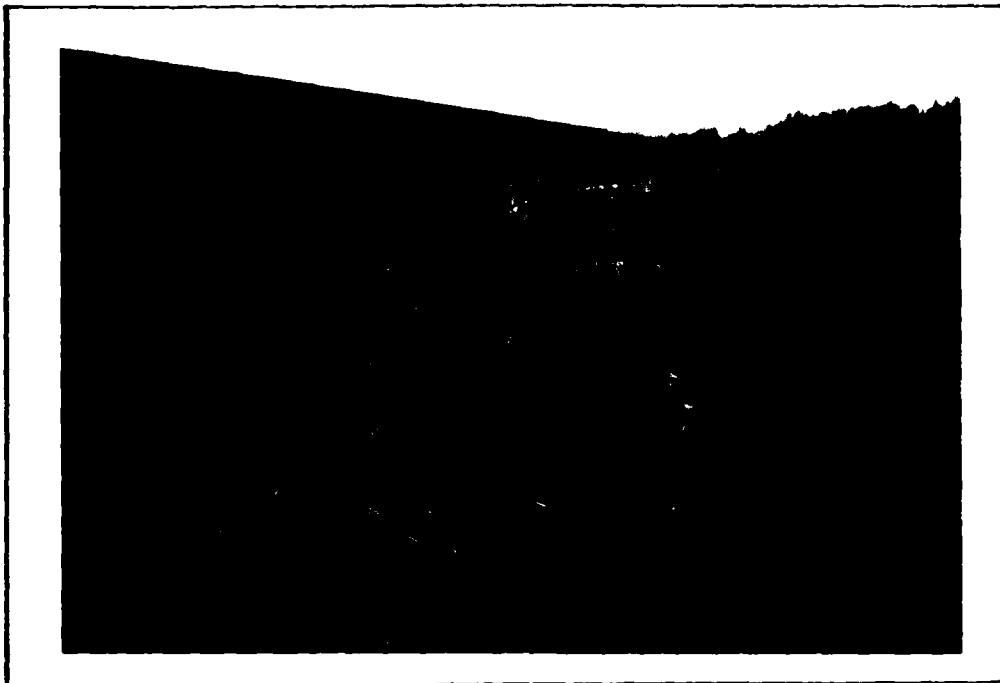
4. PRINCIPAL SPILLWAY IMPACT BASIN OUTLET STRUCTURE AND  
OUTLET CHANNEL. (11/20/79)



5. ONE OF THE TWO OUTLETS FOR THE INTERNAL DRAINAGE SYSTEM OF THE DAM. (11/20/79)



6. OVERVIEW OF THE EMERGENCY SPILLWAY BUILT INTO THE LEFT ABUTMENT OF THE DAM. (11/20/79)



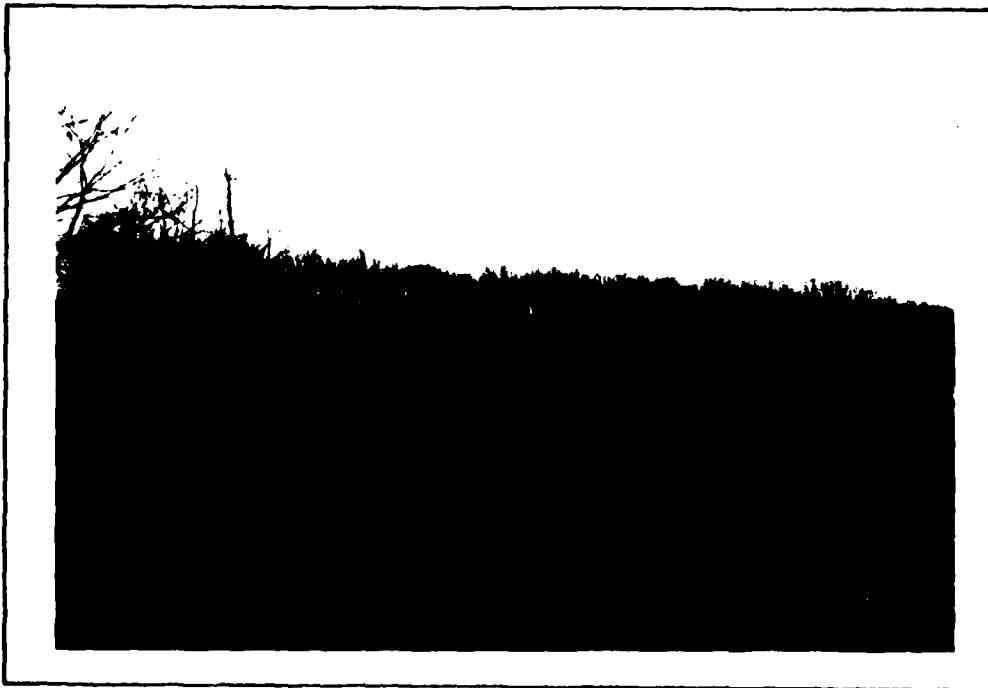
7. PAVED DRAINAGE WAY IMMEDIATELY DOWNSTREAM OF THE DAM. (11/20/79)



8. STANDING WATER IN THE INVERT OF THE EMERGENCY SPILLWAY. (11/20/79)



9. SPILLWAY FOR THE BETHLEHAM RESERVOIR DAM 1,800 FEET  
DOWNSTREAM OF LOCKWOOD DAM. (11/20/79)



10. DOWNSTREAM OVERVIEW OF BETHLEHAM RESERVOIR DAM.  
(11/20/79)



11. POTENTIAL HAZARD SITE ABOUT 3 MILES DOWNSTREAM OF THE DAM. (11/20/79)



12. POTENTIAL HAZARD SITE ABOUT 3.5 MILES DOWNSTREAM OF THE DAM. (11/20/79)

APPENDIX D

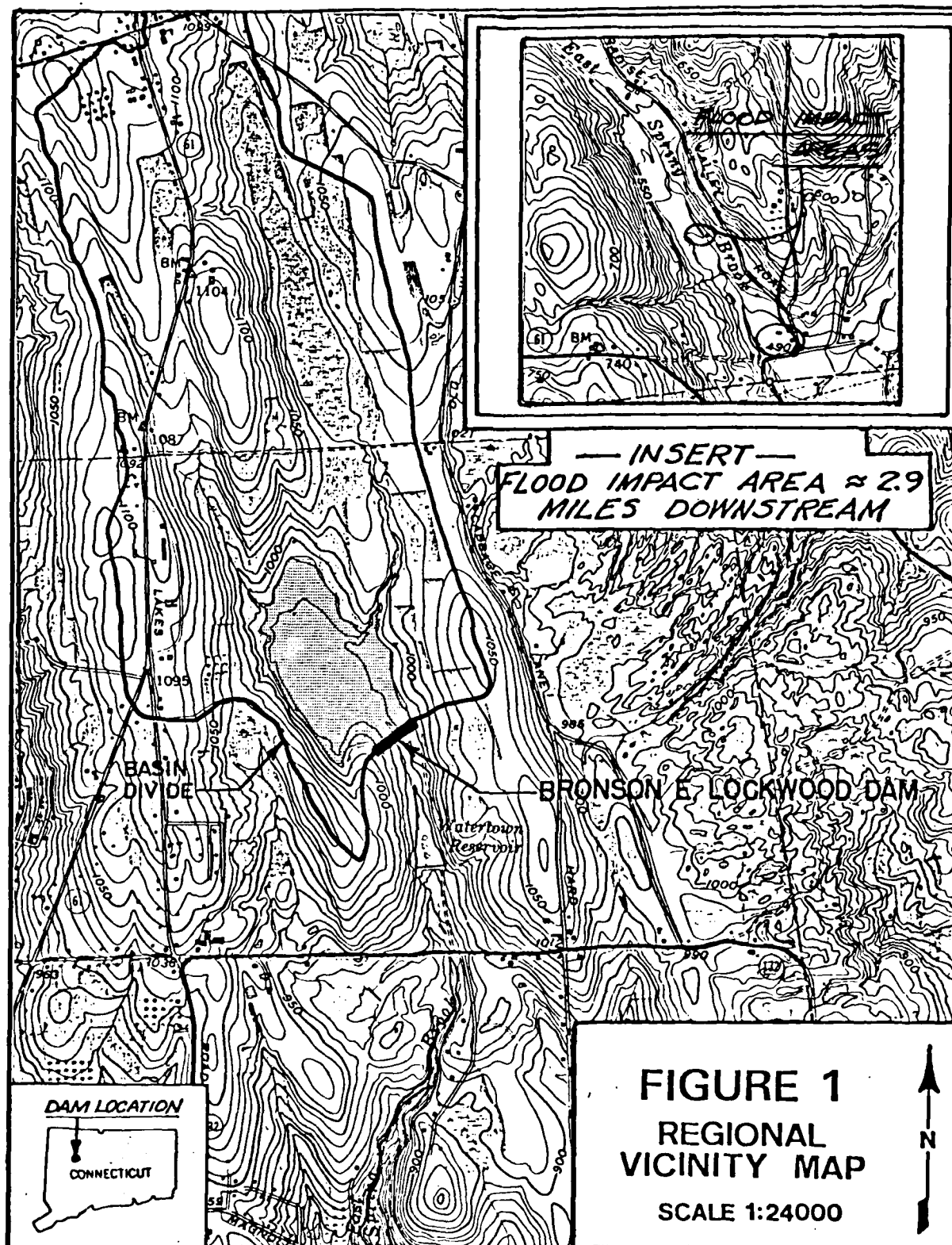
HYDROLOGIC AND HYDRAULIC COMPUTATIONS



SUBJECT	BRONSON E. LOCKWOOD DAM	SHEET	BY	DATE	JOB NO
---------	-------------------------	-------	----	------	--------

APPENDIX D  
HYDROLOGIC & HYDRAULIC COMPUTATIONS  
TABLE OF CONTENTS

	<u>PAGE</u>
REGIONAL VICINITY MAP, FIGURE 1, SHOWING FLOOD IMPACT AREA	D-1
Tp COMPUTATIONS, PMP DATA & ADDITIONAL HYDROLOGIC DATA	D-2
SPILLWAY PLAN & SECTION, EMERGENCY SPILLWAY SECTION	D-3
HYDRAULIC COMPUTATIONS	D-4 & D-5
STAGE - DISCHARGE TABULATION	D-5
STAGE - DISCHARGE & STAGE - STORAGE GRAPHS	D-6
WATERTOWN RESERVOIR H&H DATA, SPILLWAY & DAM SECTION	D-7
" " STAGE - DISCHARGE TABULATION	D-7
HAZARD CENTER INFORMATION	D-8
HEC-1 DAM SAFETY VERSION, COMPUTER OUTPUT	D-9 to D-12
HEC-1 DAM SAFETY VERSION, BREACH ANALYSIS, COMPUTER OUTPUT	D-13 to D-22



SUBJECT	SHEET	BY	DATE	JOB NO.
B.E. LOCKWOOD DAM - H <sub>2</sub> H	D-2	SHS	2/21/80	

## HYDROLOGIC & HYDRAULIC CALCULATIONS

Drainage Area - 1.4 sq. miles

Reservoir Area at El. 970 - 41 acres

Reservoir Area at El. 980 - 67 acres (Normal Pool)

Reservoir Area at El. 990 - 85 acres

RESERVOIR AREA AT EL. 954 (BOTTOM OF  
RESERVOIR) - 0 ACRES

### T<sub>p</sub> Computations :

$$L = 8500 \text{ ft.} = 1.6 \text{ mi.}$$

$$L_{CA} = 3500 \text{ ft.} = 0.7 \text{ mi.}$$

### Snyder Coefficients:

$$C_t = 2.0$$

$$C_p = 0.5$$

$$T_p = C_t (L L_{CA})^{0.3} = 2.0 (1.6 \times 0.7)^{0.3} \approx 2 \text{ Hours}$$

### PMP Data:

The 24 hr., 200 sq. mile Index Rainfall is 21.5 inches.

$$6 \text{ hr. } \% = 111$$

$$12 \text{ hr. } \% = 124$$

$$24 \text{ hr. } \% = 133$$

Ref: HMS Report #33

### Additional Hydrologic Data:

Initial Loss - 0.0 inches

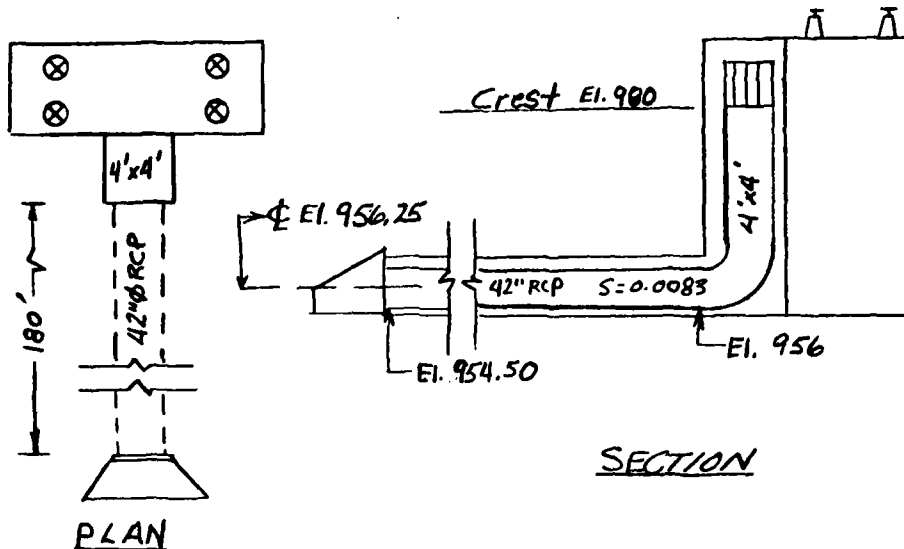
Constant Loss Rate - 0.05 in./hr.

Hop Brook Adj. Factor - 0.80

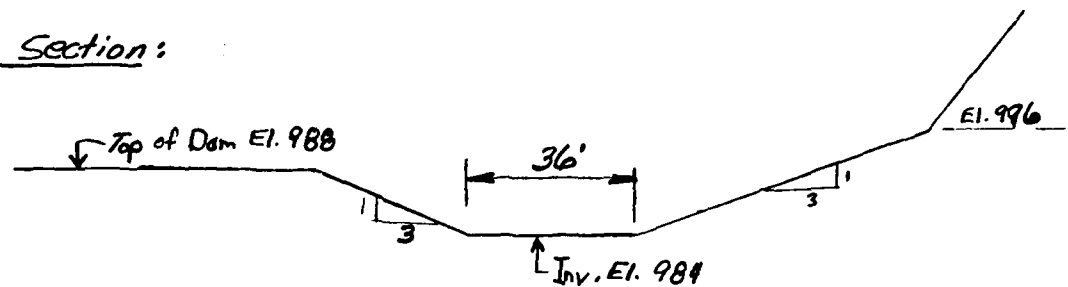
Computation Interval - 30 min.

SUBJECT	SHEET	BY	DATE	JOB NO.
B.E. LOCKWOOD DAM - H&H	D-3	SHS	2/21/80	

Drop-inlet  
Spillway Plan & Section:



Emergency Spillway Section:



Inspection of the design plans by MALCOLM PIRNIE, INC. indicates that the hydraulic works were probably designed using SCS criteria.

SUBJECT	SHEET	BY	DATE	JOB NO.
B.E. LOCKWOOD DAM - H <sub>1</sub> H	D-4	SHS	2/21/80	

### HYDRAULIC COMPUTATIONS:

The Soil Conservation Service has developed entrance coefficients for drop inlet spillways to assist in the computation of conduit discharge. (Ref. SCS Design Note No. 8, 8/19/69).

$$Q_p = C_p H_p^{1/2}, \quad C_p = A_p \left[ \frac{2g}{1 + K_r + K_f l_p} \right]^{0.5}$$

$A_p$  - Pipe Area = 9.62 sq. ft.

$K_r$  - Riser Ent. Loss Coefficient = 2.0

$K_f$  - Pipe Friction Loss Coefficient = 0.00502,  $n = 0.012$  (Ref: SCS ES-42)

$l_p$  - Pipe Length = 180'

$$C_p = 9.62 \left[ \frac{2(32.2)}{1 + 2.0 + (0.00502)(180')} \right]^{0.5}$$

$$C_p = 39.1$$

$$\therefore Q_p = 39.1 H_p^{1/2}$$

$$Q_w(\text{Weir}) = CL H_w^{3/2} \quad C = 3.1 \quad L = 3(4') = 12 \text{ ft.}$$

With reservoir pool @ El. 983.1 :

$$Q_p = 39.1 (983.1 - 956.25)^{1/2} = 203 \text{ cfs}$$

$$Q_w(\text{Weir}) = 3.1(12)(983.1 - 980)^{1.5} = 203 \text{ cfs}$$

$\therefore$  Weir flow controls to El. 983.1 and the conduit controls discharge above El. 983.1

SUBJECT	SHEET	BY	DATE	JOB NO.
B.E. LOCKWOOD DAM - H & H	D-5	SHS	2/21/80	

$$Q_D (\text{Dam}) = CL H_D^{3/2} \quad C = 2.9 \quad L = 825 \text{ ft.}$$

$$Q_{ES} (\text{Em. Spillway}) = CL H_{ES}^{3/2} \quad C = 2.9 \quad L - \text{variable w/ trapezoidal section}$$

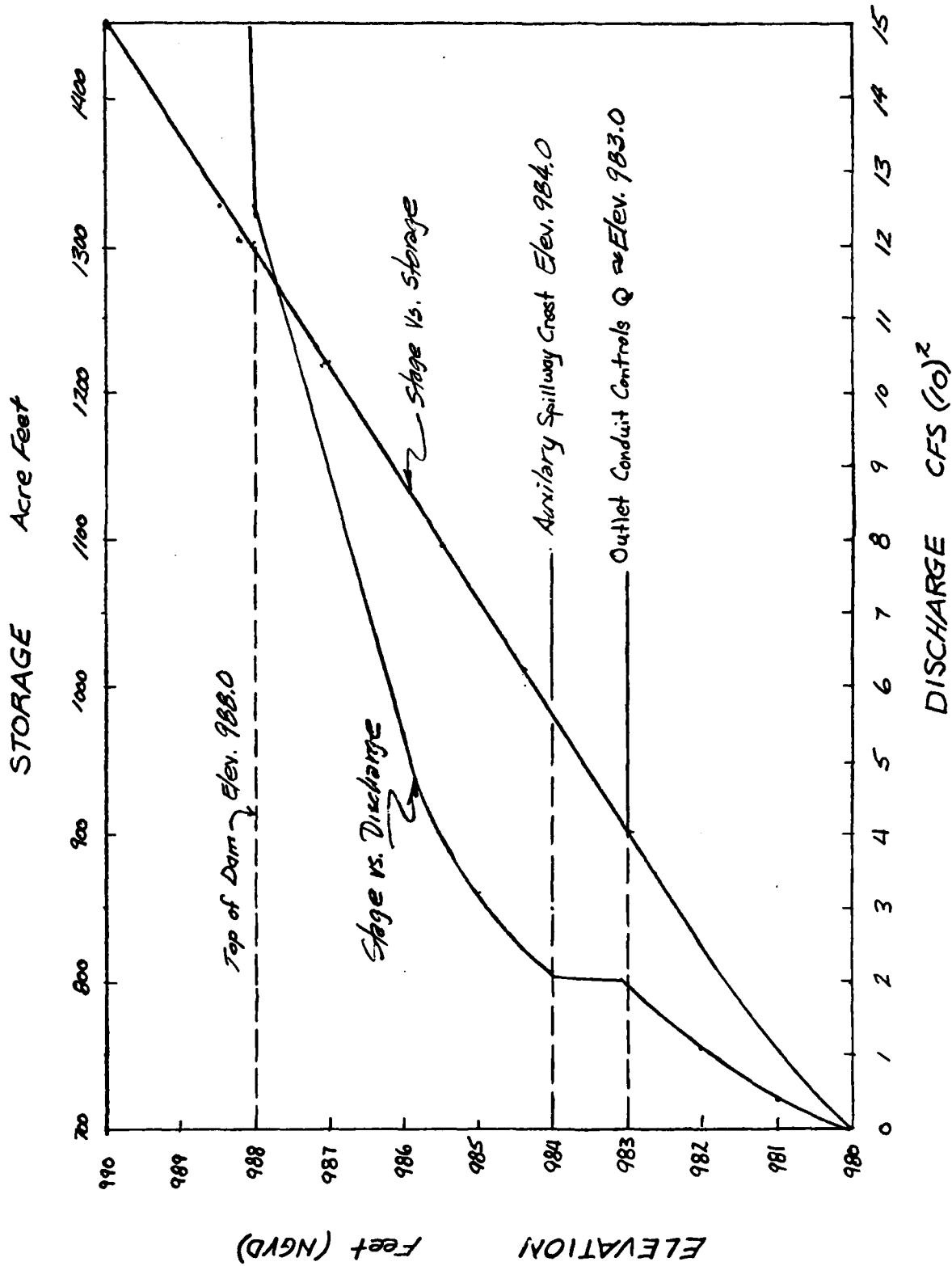
Weir width = 50 ft.  $L_{\min.} = 36 \text{ ft.}$

### STAGE - DISCHARGE TABULATION

* Pool Elev.	H <sub>w</sub> ft.	Q <sub>w</sub>	H <sub>p</sub> ft.	Q <sub>p</sub>	H <sub>ES</sub> ft.	Q <sub>ES</sub>	H <sub>D</sub> ft.	Q <sub>D</sub>	Σ Q cfs
980	0	0	0	0	0	0	0	0	0
981	1	37	24.75	-	0	-	0	-	37
982	2	105	25.75	-	0	-	0	-	105
983	3	193	26.75	202	0	-	0	-	193
984	4	298	27.75	206	0	-	0	-	206
985	5	-	28.75	210	1	110	0	-	320
986	6	-	29.75	213	2	320	0	-	533
988	8	-	31.75	220	4	1021	0	-	1241
989	9	-	32.75	224	5	1597	1	2393	4214
990	10	-	33.75	227	6	2238	2	6767	9232

\* NGVD

SUBJECT	SHEET	BY	DATE	JOB NO
B.E. LOCKWOOD DAM - H&H	D-6	SHS	2/28/80	



Reservoir storage at spillway crest El. 980 is 699 AF

SUBJECT	SHEET	BY	DATE	JOB NO
B.E. LOCKWOOD DAM - H&H	D-7	SHS	2/29/80	

Watertown Reservoir - Located about 0.35 miles downstream of study dam.

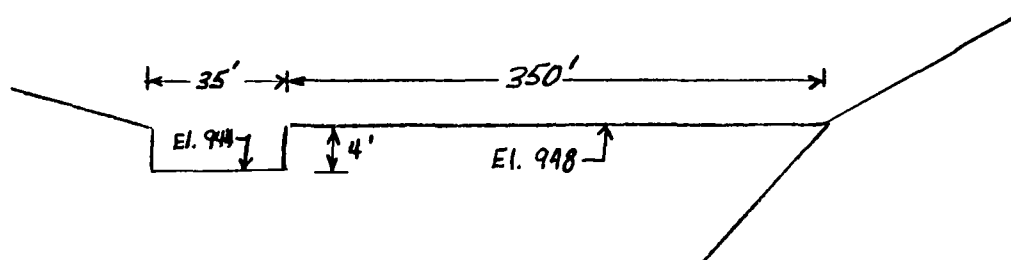
Surface Area at Normal Pool El. 944 - 2.6 acres

Surface Area at El. 950 - 4.0 acres

Surface Area at El. 940 - 0 acres

Surface Area at El. 960 - 8.0 acres

Spillway & Dam Section



$$Q_s (\text{Broad-crested weir}) = CLH_s^{3/2} \quad C = 3.0$$

$$Q_D (\text{Dam Crest}) = CLH_D^{3/2} \quad C = 2.9$$

STAGE-DISCHARGE TABULATION

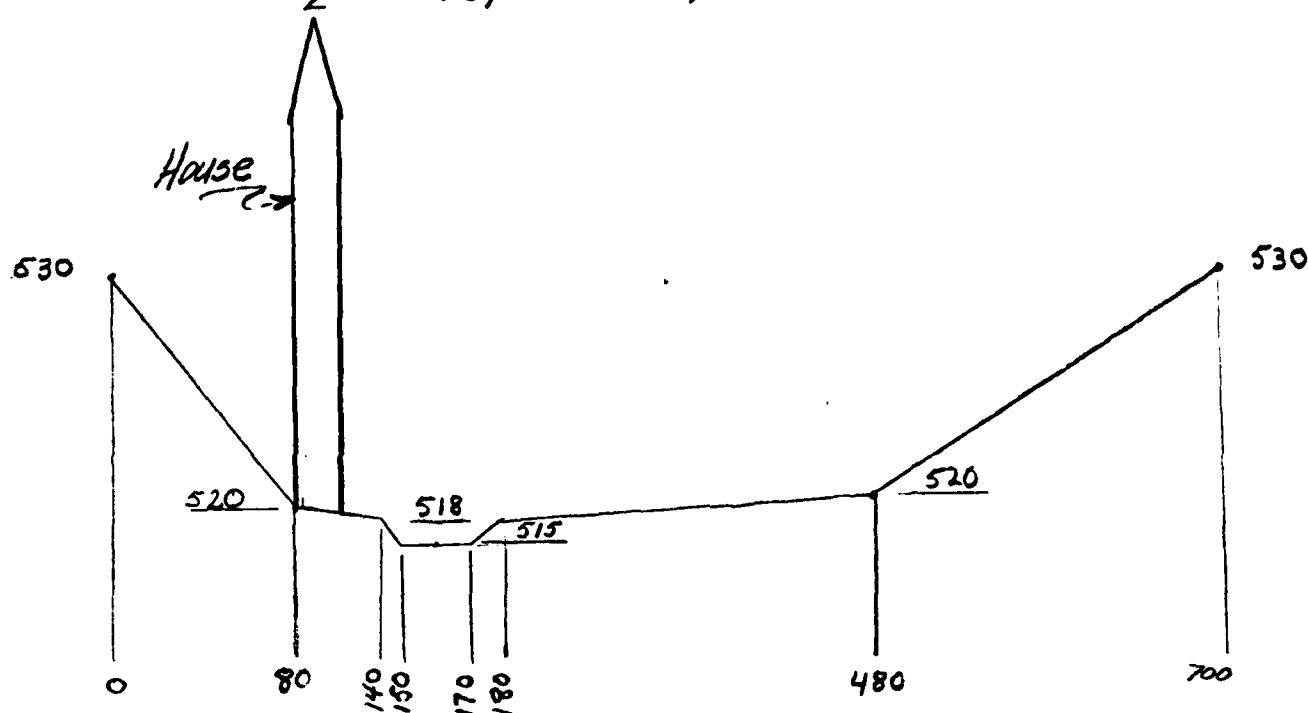
Pool Elevation	$H_s$	$Q_s$	$H_D$	$Q_D$	$\Sigma Q$ cfs
944	0	0	0	-	0
945	1	105	0	-	105
946	2	297	0	-	297
947	3	546	0	-	546
948	4	840	0	-	840
950	6	1543	2	2871	4414
952	8	2376	4	8120	10,496
954	10	3320	6	14,917	18,237
956	12	4365	8	22,967	27,332



SUBJECT	SHEET	BY	DATE	JOB NO
B.E. LOCKWOOD DAM - H&H	D-8	SMS	2/21/80	

Hazard Center : 15,500 feet downstream

$$S = \frac{\Delta H}{L} = \frac{958 - 515}{15,500} = \frac{443}{15,500} = 0.029 \text{ ft./ft.}$$



SECTION

Manning's Coefficients :

Stream - 0.035

Overbanks - 0.060

\*\*\*\*\*  
FLOOD HYDROGRAPH PACKAGE (HEC-1)  
DAM SAFETY VERSION JULY 1978  
LAST MODIFICATION 26 FEB 79  
\*\*\*\*\*

HYDROLOGIC ANALYSTS OF B.E. LOCKWOOD DAM  
NATIONAL DAM INSPECTION PROGRAM  
NEW ENGLAND DIVISION - CORPS OF ENGINEERS

D-9

RUN DATE 02/26/80.  
 TIME 09.49.33.

HYDROLOGIC ANALYSIS OF H.E. LOCKWOOD DAM  
NATIONAL DAM INSPECTION PROGRAM  
NEW ENGLAND DIVISION - CORPS OF ENGINEERS

JOB SPECIFICATION									
NO	NHR	NMIN	LDAY	IMN	IMIN	METMC	IPLT	IRPT	NSTAN
000	0	15		0	0	0	0	0	0
			JOPEH	NWT	LRUPT	TRACE			
			5	0	0	0			

## MULTI-PLAN ANALYSES TO BE PERFORMED

PERCENTAGES OF PMF USED	→ RTIUS =	MPICNE =	WRTIU =	Y	RTIU =	1
	.20	.30	.40	.50	.60	.70
						.80
						.90
						1.00

INFLOW HYDROGRAPH DEVELOPMENT  
FOR LOCKWOOD RESERVOIR

[illegible]

## HYDROGRAPH DATA

TRYING	JUNG	TRAP4	SNAP	TRSD4	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.40	0.00	1.40	0.00	0.000	0	1	0

**PREFCIP DATA**

	WMS	R6	R12	R24	R48	R72	R96
SPFE	21.50	111.00	124.00	133.00	0.00	0.00	0.00

TRANSPEC COMPUTED BY THE PROGRAM IS .800

### LOSS DATA

CROSS DATA											
EXPROPT	STRKR	DLTKR	HTLOE	ERAIN	STRKS	HTLOK	STRIL	CNSTL	ALSHX	HTYMP	
0	0.00	0.00	1.00	0.00	0.00	1.00	0.00	.05	0.00	0.00	

## UNIT HYDROGRAPH DATA

```

UNIT HYDROGRAPH DATA
TYPE= 2.00 CP= .50 NTA= 0

```

**REFERENCE DATA**

```

RECESSION DATA
SFRTU= -1.70 QWCSN= -.10 RTIOR= 2.00

```

UNIT HYDROGRAPH 62 END=OF=PERIOD DATES: LAG= 2.02 HOURS; CP= .50 VOL= 1.00

9.	33.	68.	117.	150.	187.	213.	228.	227.	212.
93.	176.	160.	146.	133.	121.	111.	101.	92.	84.
76.	70.	63.	58.	53.	48.	44.	40.	36.	33.
30.	28.	25.	23.	21.	19.	17.	16.	14.	13.
12.	11.	10.	9.	8.	8.	7.	6.	6.	5.

0	MO,DA	HH,MM	PERIOD	MAIN	EXCS	LUSS	COMP 0	MO,DA	HH,MM	PERIOD	RAIN	EXCS	LOSS	COMP 0
END-OF-PERIOD FLOW														

SUM	22.44	21.64	1.20	79356.
-----	-------	-------	------	--------

PRINTED IN U.S.A.

STAGE - DISCHARGE DATA  
FOR LOCKWOOD RESERVOIR  
DAM

HYDROGRAPH ROUTING														
ROUTED OUTFLOW FROM LOCKWOOD RESERVOIR														
ISTAW LOCK	ICOMP 1	IECUN 0	ITAPE 0	JPLT 0	JPRI 0	INAME 1	ISTAGE 0	IAUTO 0						
ROUTING DATA														
QLUSS 0.0	CLUSS 0.000	AVG 0.00	IMES 1	ISAME 1	IOPT 0	IPMP 0	LSTR 0							
NSIPS 1	NSTDL 0	LAG 0	AMSKK 0.000	X 0.000	TSK 0.000	STORA -980.	ISPRAT -1							
STAGE 980.00	981.00	982.00	983.00	984.00	985.00	986.00	988.00	989.00	990.00					
FLOW 0.00	37.00	105.00	203.00	206.00	320.00	533.00	1281.00	4214.00	9232.00					
SURFACE AREA*	0.	41.	67.	85.										
CAPACITY*	0.	104.	699.	1457.										
ELEVATIONS	958.	970.	980.	990.										
STAGE-STORAGE DATA FOR LOCKWOOD RESERVOIR DAM														
DAM DATA														
TOPEL 986.0	COOD 0.0	EXPV 0.0	ELEVL 0.0	COOL 0.0	CAHEA 0.0	EXPL 0.0								
TOP OF DAM ELEVATION→ 986.0														
PEAK OUTFLOW IS 196. AT TIME 22.00 HOURS														
PEAK OUTFLOW IS 253. AT TIME 22.25 HOURS														
PEAK OUTFLOW IS 432. AT TIME 21.50 HOURS														
PEAK OUTFLOW IS 671. AT TIME 21.00 HOURS														
PEAK OUTFLOW IS 924. AT TIME 20.50 HOURS														
PEAK OUTFLOW IS 1161. AT TIME 20.50 HOURS														
ROUTED OUTFLOWS FROM LOCKWOOD RESERVOIR DAM FOR VARIOUS FLOODS														

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
			.20	.30	.40	.50	.60	.70	.80	.90	1.00
RATIOS APPLIED TO FLOWS											
HYDROGRAPH AT	LOCK	1.40 (3.63)	1 (16.81)	546. (24.91)	880. (33.21)	1173. (41.52)	1466. (59.82)	1759. (78.12)	2053. (86.83)	2346. (96.73)	2932. (133.03)
ROUTED TO	LOCK	1.40 (3.63)	1 (16.81)	146. (5.55)	253. (7.16)	432. (12.24)	671. (19.01)	924. (26.15)	1161. (48.58)	1714. (61.80)	2595. (93.89)

PEAK INFLOWS

ROUTED OUTFLOWS

LOCKWOOD RESERVOIR DAM  
 FLOOD ROUTING RESULTS

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....											
ELEVATION		INITIAL VALUE		SPILLWAY CREST		TOP OF DAM					
STORAGE		980.00		980.00		988.00					
OUTFLOW		699.		699.		1291.					
		0.		0.		1241.					
		SPILLWAY CAPACITY									
RATIO OF		MAXIMUM		MAXIMUM STORAGE		MAXIMUM OUTFLOW		DURATION OVER TOP		TIME OF MAX OUTFLOW	
PMP		W.S.ELEV		OVER DAM		AC-FT		CFS		HOURS	

LOCKWOOD DAM BREACH (WITH RESERVOIR AT TOP OF DAM)  
OUTFLOW ROUTED TO DOWNSTREAM DAMAGE AREA

**WFO**

HYDROLOGIC ANALYSIS OF R.F. LOCKWOOD DAM  
NATIONAL DAM INSPECTION PROGRAM  
NEW ENGLAND DIVISION - CORPUS OF ENGINEERS

[illegible]

.....  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1970  
 LAST MODIFICATION 26 FEB 79  
 .....

RUN DATE 04/02/80.  
 TIME 14.30.51.

HYDROLOGIC ANALYSIS OF R.E. LOCKWOOD DAM  
 NATIONAL DAM INSPECTION PROGRAM  
 NEW ENGLAND DIVISION - CORPS OF ENGINEERS

JOB SPECIFICATION  
 NO MHR NMN IOAY ITH IMIN METRC IMLT IPRT NSTAN  
 300 0 5 0 0 0 0 0 0 0 0 0  
 JOBER NWT LROPT TRACE  
 5 0 0 0 0 0

MULTI-PLAN ANALYSES TO BE PERFORMED  
 NPLAN= 2 NRTIO= 1 LRTIO= 1

NO INFLOW -> RTIOS= 0.00

HYDROGRAPH ROUTING

ROUTED OUTFLOW FROM LOCKWOOD RESERVOIR

ISTAU	ICOMP	IECON	ITAPE	JPLT	JPHF	IMAHF	ISTAGE	IAUID
LOCK	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME  
 ROUTING DATA

QLOSS	CLOSS	AVG	IRCS	ISAME	IORT	IPMP	ISTR
0.0	0.000	0.00	1	1	0	0	0

NSIPS	NSIDL	LAG	AMSKK	A	ISK	STUHA	ISPOAT
1	0	0	0.000	0.000	0.000	-000.	-

STAGE	990.00	982.00	983.00	985.00	985.00	986.00
FLOW	0.00	37.00	105.00	203.00	204.00	320.00

STAGE	990.00	982.00	983.00	985.00	985.00	986.00
FLOW	0.00	37.00	105.00	203.00	204.00	320.00

SURFACE AREA= 0. 41. 67. 85.  
 CAPACITY= 0. 164. 699. 1457.

ELEVATION= 958. 970. 980. 990.

CREL	SPWID	COOW	EXPW	EVEL	COUL	CAREA	EXPL
980.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOP OF DAM ELEVATION -> 988.0

BMWID	FLRM	TFALL	WSEL	FAILEL
124.	.01	960.00	1.00	943.00

DAM BREACH DATA  
 WSEL 943.00  
 FAILEL 943.00

BEGIN DAM FAILURE AT 0.00 HOURS

PEAK OUTFLOW IS 18677, AT TIME .92 HOURS

MAXIMUM BREACH DISCHARGE

AT TIME 0.00 HOURS -> MAXIMUM SPILLWAY DISCHARGE PRIOR TO BREACH

PEAK OUTFLOW IS 1241, AT TIME 0.00 HOURS

STAGE-DISCHARGE DATA  
 FOR LOCKWOOD DAM

STAGE	990.00	989.00	988.00
DISCHARGE	990.00	989.00	988.00

STAGE-STORAGE DATA  
 FOR LOCKWOOD DAM

STAGE	990.00	989.00	988.00
STORAGE	990.00	989.00	988.00

UNITED COMPUTING SYSTEMS, INC.  
 BREACH DIMENSIONS - FAILURE BEGINS  
 IMMEDIATELY WITH RESERVOIR SURFACE  
 AT TOP OF DAM

BREACH DIMENSIONS - NO  
 FAILURE OCCURS

PEAK OUTFLOW IS 1241, AT TIME 0.00 HOURS -> MAXIMUM SPILLWAY DISCHARGE PRIOR TO BREACH

FLOODS ROUTED THROUGH  
WATERTOWN RESERVOIR  
(LOCATED IMMEDIATELY  
DOWNSTREAM)

ROUTING THROUGH WATERTOWN RESERVOIR  
HYDROGRAPH ROUTING

ISTAD WATN	ICOMP 1	IECON 0	ITAPE 0	JPLT 0	JPRT 0	ISTAGE 0	LAUTO 0
---------------	------------	------------	------------	-----------	-----------	-------------	------------

ALL PLANS HAVE SAME  
ROUTING DATA

QLOSS 0.0	CLOSS 0.000	AVG 0.00	IRCS 1	ISAME 1	IOPT 0	ISMP 0	LSTM 0
--------------	----------------	-------------	-----------	------------	-----------	-----------	-----------

NSFOS 1	NSIDL 0	LAG 0	AMSKK 0	ISK 0.000	STOMA -944.	ISPHAT -1
------------	------------	----------	------------	--------------	----------------	--------------

STAGE	944.00	945.00	946.00	947.00	948.00	950.00	952.00	954.00	956.00
FLOW	0.00	105.00	297.00	546.00	840.00	4414.00	10444.00	14237.00	27332.00

STAGE-STORAGE DATA FOR  
WATERTOWN RESERVOIR DAM

CREL	SPWID	COOW	EXPW	FLEVL	COOL	CAREA	FXPL
944.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOPEL 944.0  
DAM DATA  
COOD 0.0  
EAPD 0.0  
DAMFID 0.

TOP OF DAM ELEVATION 18672. AT TIME .92 HOURS

PEAK OUTFLOW IS 1121. AT TIME .33 HOURS

ROUTED OUTFLOW DUE TO LOCKWOOD BREACH

ROUTED OUTFLOW DUE TO LOCKWOOD SPILLWAY DISCHARGE



# Flows Routed To Downstream Damage Area

HYDROGRAPH ROUTING  
CHANNEL ROUTING TO HAZARD CENTER

UNITED COMPUTING SYSTEMS, INC.

ALL PLANS HAVE SAME  
ROUTING DATA

ROUTING DATA

## NORMAL DEPTH CHANNEL ROUTING

DOWNSTREAM CHANNEL CHARACTERISTICS

CROSS SECTION COORDINATES--STA+ELEV, STA+ELEV--ETC

CHANNEL CROSS-SECTION  
AT HAZARD AREA

STAGE-STORAGE AND  
STAGE-DISCHARGE DATA  
FOR DOWNSTREAM CHANNEL

MAXIMUM STREAM ELEVATION AT DAMAGE CENTER DUE TO LOCKWOOD BREACH

MAXIMUM STREAM ELEVATION AT DAMAGE CENTER DUE TO LOCKWOOD SPILLWAY DISCHARGE

# LOCKWOOD DAM BREACH OUTFLOW RESULTS

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....				PLAN 2 .....			
ELEVATION		INITIAL VALUE	SPILLWAY CREST	ELEVATION		INITIAL VALUE	SPILLWAY CREST
STORAGE		988.00	980.00	STORAGE		988.00	980.00
OUTFLOW		1291.	699.	OUTFLOW		1291.	699.
		1241.	0.			1241.	0.

RATIO OF PMF 0.00  
 MAXIMUM DEPTH OVER DAM 0.00  
 MAXIMUM STORAGE AC-FT 1291.  
 MAXIMUM OUTFLOW CFS 699.  
 DURATION OVER TOP HOURS 0.00  
 TIME OF FAILURE HOURS 0.00

# LOCKWOOD DAM SPILLWAY DISCHARGE RESULTS

PLAN 1 .....				PLAN 2 .....			
ELEVATION		INITIAL VALUE	SPILLWAY CREST	ELEVATION		INITIAL VALUE	SPILLWAY CREST
STORAGE		988.00	980.00	STORAGE		988.00	980.00
OUTFLOW		1291.	699.	OUTFLOW		1291.	699.
		1241.	0.			1241.	0.

RATIO OF PMF 0.00  
 MAXIMUM DEPTH OVER DAM 0.00  
 MAXIMUM STORAGE AC-FT 1291.  
 MAXIMUM OUTFLOW CFS 699.  
 DURATION OVER TOP HOURS 0.00  
 TIME OF FAILURE HOURS 0.00

# WATERTOWN RESERVOIR DAM OUTFLOW RESULTS DUE TO LOCKWOOD BREACH

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....				PLAN 2 .....			
ELEVATION		INITIAL VALUE	SPILLWAY CREST	ELEVATION		INITIAL VALUE	SPILLWAY CREST
STORAGE		944.00	944.00	STORAGE		944.00	944.00
OUTFLOW		0.	0.	OUTFLOW		0.	0.
		0.	0.			0.	0.

RATIO OF PMF 0.00  
 MAXIMUM DEPTH OVER DAM 6.10  
 MAXIMUM STORAGE AC-FT 39.  
 MAXIMUM OUTFLOW CFS 18672.  
 DURATION OVER TOP HOURS 1.42  
 TIME OF FAILURE HOURS 0.00

# WATERTOWN RESERVOIR DAM OUTFLOW RESULTS DUE TO LOCKWOOD SPILLWAY DISCHARGE

PLAN 1 .....				PLAN 2 .....			
ELEVATION		INITIAL VALUE	SPILLWAY CREST	ELEVATION		INITIAL VALUE	SPILLWAY CREST
STORAGE		944.00	944.00	STORAGE		944.00	944.00
OUTFLOW		0.	0.	OUTFLOW		0.	0.
		0.	0.			0.	0.

RATIO OF PMF 0.00  
 MAXIMUM DEPTH OVER DAM 0.16  
 MAXIMUM STORAGE AC-FT 13.  
 MAXIMUM OUTFLOW CFS 1121.  
 DURATION OVER TOP HOURS 0.92  
 TIME OF FAILURE HOURS 0.00

# FLOW CONDITIONS AT DAMAGE CENTER DUE TO LOCKWOOD BREACH

PLAN 1 .....				PLAN 2 .....			
RATIO		MAXIMUM FLOW-CFS	MAXIMUM STAGE-FT	RATIO		MAXIMUM FLOW-CFS	MAXIMUM STAGE-FT
		0.00	15189.			0.00	522.0

# FLOW CONDITIONS AT DAMAGE CENTER DUE TO LOCKWOOD SPILLWAY DISCHARGE

PLAN 1 .....				PLAN 2 .....			
RATIO		MAXIMUM FLOW-CFS	MAXIMUM STAGE-FT	RATIO		MAXIMUM FLOW-CFS	MAXIMUM STAGE-FT
		0.00	435.			0.00	517.7

PEAK FLOW AT HAZARD AREA DUE TO LOCKWOOD BREACH

PEAK FLOW AT HAZARD AREA DUE TO LOCKWOOD SPILLWAY DISCHARGE

\*\*\*\*\*  
FLOOD HYDROGRAPH PACKAGE (HEC-1)  
DAM SAFETY VERSION JULY 1978  
LAST MODIFICATION 26 FEB 79  
\*\*\*\*\*

INPUT

HYDROLOGIC ANALYSIS OF R.E. LOCKWOOD DAM  
NATIONAL DAM INSPECTION PROGRAM  
NEW ENGLAND DIVISION - CORPS OF ENGINEERS

	LOCK ROUTED OUTFLOW FROM LOCKWOOD RESERVOIR										
	1					1					
4	B	300	0	5	0	0	0	0	0	0	-4
5	B1	5									
6	J	1	1	1							
7	J1	0									
8	K	1									
9	K1										
10	Y										
11	Y1	1									
12	Y4	980	981	982	983	984	985	986	988	989	990
13	Y5	0	37	105	203	206	320	533	1241	4214	9232

14	SA	0	41	67	85
15	SE	958	970	980	990

16	\$ 980
17	\$ 980

10	SB	124	0.01	960	1	980
19	K	1	WATN			1

20	K1	ROUTING THROUGH WATERTOWN RESERVOIR
21	Y	1

22	Y1	945	946	947	948	950	952	-944	-1
23	Y4	944							

24	Y5	0	105	297	546	A40	441.4	10496	18237	27332
25	SA	2.6	4.0	8.0						

26	\$E	944	950	960
27	\$S	944		

SD	948
K	1 HAZARD

[illegible]

	Y1	Y6	Y7	Y1	Y6	Y7
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
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97						
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99						
100						

36	Y	530	80	520	700	530
35	Y	180	510	480	520	530
34	Y	80				530

[illegible]

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18

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100

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100

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 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 26 FEB 79  
 \*\*\*\*\*

RUN DATE 02/29/80.  
 TIME 12.21.30.

HYDROLOGIC ANALYSIS OF B.E. LOCKWOOD DAM  
 NATIONAL DAM INSPECTION PROGRAM  
 NEW ENGLAND DIVISION - CORPS OF ENGINEERS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	-4	0
	JOPER	NWT	LROPT	TRACE					
	5	0	0	0					

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 1 LRTIO= 1

NO INFLOW → RTIOS= 0.00

HYDROGRAPH ROUTING

ROUTED OUTFLOW FROM LOCKWOOD RESERVOIR

ISIAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LOCK	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPHP	LSTR
0.0	0.00	0.00	1	1	0	0	0

NSIPS	NSIDL	LAG	AMSCK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-980.	-1

STAGE	980.00	981.00	982.00	983.00	984.00	985.00	986.00	988.00	989.00	990.00
FLOW	0.00	37.00	105.00	203.00	206.00	320.00	533.00	1241.00	4214.00	9232.00

STAGE-DISCHARGE DATA FOR LOCKWOOD RESERVOIR DAM

SURFACE AREA= 0. 41. 67. 85. 147. 1457. 1457. 1457. 1457. 1457. 1457.

CAPACITY= 0. 164. 698. 1457. 1457. 1457. 1457. 1457. 1457. 1457. 1457.

ELEVATION= 958. 970. 980. 990.

SPILLWAY CREST ELEVATION → 980.0 CREL SPWID COGW EXPW ELEV ELEV COOL CAREA EXPL

TOP OF DAM ELEVATION → 988.0 TOPEL COOD EXPD DAMWID

BRWID Z FLBM TFAIL WSEL FTAILE

BREACH CHARACTERISTICS - FAILURE BEGINS IMMEDIATELY WITH RESERVOIR SURFACE AT SPILLWAY CREST

BEGIN DAM FAILURE AT 0.00 HOURS

PEAK OUTFLOW IS 14349. AT TIME 1.00 HOURS

ROUTED BREACH OUTFLOW

HYDROGRAPH ROUTING														
ROUTING THROUGH WATERTOWN RESERVOIR														
BREEM OUTFLOW ROUTED THROUGH WATERTOWN RESERVOIR DAM (LOCATED IMMEDIATELY DOWNSTREAM)														
STAGE	944.00	945.00	946.00	947.00	948.00	949.00	950.00	951.00	952.00	953.00	954.00	955.00	956.00	957.00
FLW	0.00	105.00	297.00	546.00	840.00	1049.00	1237.00	1423.00	1609.00	1795.00	1981.00	2167.00	2353.00	2539.00
STAGE - STORAGE DATA FOR WATERTOWN RESERVOIR DAM														
SURFACE AREA	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
CAPACITY	0.	20.	79.	179.	319.	500.	721.	982.	1283.	1624.	1995.	2396.	2827.	3288.
ELEVATION	944.	950.	960.	970.	980.	990.	1000.	1010.	1020.	1030.	1040.	1050.	1060.	1070.
STAGE - DISCHARGE DATA FOR WATERTOWN RESERVOIR DAM														
SPILLWAY GUEST ELEVATION	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0
DAM DATA														
TOP OF DAM ELEVATION	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0	944.0
PEAR OUTFLOW IS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

*****										*****										*****											
HYDROGRAPH ROUTING																															
CHANNEL ROUTING TO HAZARD CENTER																															
BREACH OUTFLOW ROUTED										DOWNSTREAM TO DAMAGE AREA																					
HAZARD										1	0	0	0	0	0	1	0	0													
ROUTING DATA																															
QLOSS					CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR																				
0.0					0.000	0.00	1	1	0	0	0																				
NSTPS					NSIDL	LAG	ANSKK	X	TSK	SIORA	ISPRAT																				
1					0	0	0.000	0.000	0.000	-1.	0																				

NORMAL DEPTH CHANNEL ROUTING										
DOWNSTREAM CHANNEL CHARACTERISTICS										
QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL	CHANNEL CROSS-SECTION AT HAZARD AREA			
0.0600	0.0350	0.0600	515.0	530.0	15500.	.02900				
CROSS SECTION COORDINATES--STA.ELEV., STA.ELEV.--ETC										
0.00	530.00	80.00	520.00	140.00	518.00	150.00	515.00	170.00	515.00	
180.00	518.00	480.00	520.00	700.00	530.00					
STORAGE	0.00	6.36	14.19	23.51	35.07	74.25	153.35	264.98	385.11	511.89
	645.33	785.42	932.16	1085.56	1245.61	1412.31	1585.67	1765.68	1952.34	2145.66
OUTFLOW	0.00	102.20	342.19	711.56	1238.08	2190.88	3909.98	6902.67	11055.22	16179.56
	22239.58	29218.57	37110.63	45916.60	55641.75	66294.40	77885.06	90425.85	103930.02	118411.75
STAGE	515.00	515.79	516.58	517.37	518.16	518.95	519.74	520.53	521.32	522.11
	522.89	523.68	524.47	525.26	526.05	526.84	527.63	528.42	529.21	530.00
FLOW	0.00	102.20	342.19	711.56	1238.08	2190.88	3909.98	6902.67	11055.22	16179.56
	22239.58	29218.57	37110.63	45916.60	55641.75	66294.40	77885.06	90425.85	103930.02	118411.75
MAXIMUM STAGE IS 520.9 MAXIMUM STREAM ELEVATION AT DAMAGE CENTER										

STAGE-STORAGE AND  
STAGE-DISCHARGE DATA  
FOR DOWNSTREAM CHANNEL

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

INITIAL VALUE	980.00	SPIRITWAY CREDIT	980.00	TOP OF OAK
699.		699.		1291.
0.		0.		1241.

10.00	980.00	988.00
699.	699.	1291.
0.	0.	1241.

10.00	980.00	988.00
699.	699.	1291.
0.	0.	1241.

10.00	980.00	988.00
699.	699.	1291.
0.	0.	1241.

RATIO OF PNE	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF PNE	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO	MAXIMUM RESERVOIR W.S.ELEV PNE	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO	MAXIMUM RESERVOIR W.S.ELEV PNE	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF PNE	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF PNE	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF PNE	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF PNE	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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## WATERTOWN RESERVOIR DAM

**PLAN 1 .....**

INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
944.00	944.00	948.00

44.00	944.00	948.00
0.	0.	12.
0.	0.	840.

44.00	944.00	948.00
0.	0.	12.
0.	0.	840.

44.00	944.00	948.00
0.	0.	12.
0.	0.	840.

RATIO OF	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM OVER DAM DEPTH	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM OVER DAM DEPTH	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM OVER DAM DEPTH	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM OVER DAM DEPTH	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM OVER DAM DEPTH	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM OVER DAM DEPTH	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM STORAGE OVER DAM	MAXIMUM ACFT OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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RATIO OF	MAXIMUM RESERVOIR W-S-ELEV	MAXIMUM STORAGE OVER DAM	MAXIMUM AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
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DOWNSTREAM CHANNEL  PLAN 1 STATION HAZARD

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.0	100	10.0	1.0
1.2	120	10.2	1.2
1.4	140	10.4	1.4
1.6	160	10.6	1.6
1.8	180	10.8	1.8
2.0	200	11.0	2.0
2.2	220	11.2	2.2
2.4	240	11.4	2.4
2.6	260	11.6	2.6
2.8	280	11.8	2.8
3.0	300	12.0	3.0
3.2	320	12.2	3.2
3.4	340	12.4	3.4
3.6	360	12.6	3.6
3.8	380	12.8	3.8
4.0	400	13.0	4.0
4.2	420	13.2	4.2
4.4	440	13.4	4.4
4.6	460	13.6	4.6
4.8	480	13.8	4.8
5.0	500	14.0	5.0
5.2	520	14.2	5.2
5.4	540	14.4	5.4
5.6	560	14.6	5.6
5.8	580	14.8	5.8
6.0	600	15.0	6.0
6.2	620	15.2	6.2
6.4	640	15.4	6.4
6.6	660	15.6	6.6
6.8	680	15.8	6.8
7.0	700	16.0	7.0
7.2	720	16.2	7.2
7.4	740	16.4	7.4
7.6	760	16.6	7.6
7.8	780	16.8	7.8
8.0	800	17.0	8.0
8.2	820	17.2	8.2
8.4	840	17.4	8.4
8.6	860	17.6	8.6
8.8	880	17.8	8.8
9.0	900	18.0	9.0
9.2	920	18.2	9.2
9.4	940	18.4	9.4
9.6	960	18.6	9.6
9.8	980	18.8	9.8
10.0	1000	19.0	10.0

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
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RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.0	100	10.0	1.0
1.5	150	10.5	1.5
2.0	200	11.0	2.0
2.5	250	11.5	2.5
3.0	300	12.0	3.0
3.5	350	12.5	3.5
4.0	400	13.0	4.0
4.5	450	13.5	4.5
5.0	500	14.0	5.0
5.5	550	14.5	5.5
6.0	600	15.0	6.0
6.5	650	15.5	6.5
7.0	700	16.0	7.0
7.5	750	16.5	7.5
8.0	800	17.0	8.0
8.5	850	17.5	8.5
9.0	900	18.0	9.0
9.5	950	18.5	9.5
10.0	1000	19.0	10.0

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.0	100	10.0	1.0
1.5	150	15.0	1.5
2.0	200	20.0	2.0
2.5	250	25.0	2.5
3.0	300	30.0	3.0
3.5	350	35.0	3.5
4.0	400	40.0	4.0
4.5	450	45.0	4.5
5.0	500	50.0	5.0
5.5	550	55.0	5.5
6.0	600	60.0	6.0
6.5	650	65.0	6.5
7.0	700	70.0	7.0
7.5	750	75.0	7.5
8.0	800	80.0	8.0
8.5	850	85.0	8.5
9.0	900	90.0	9.0
9.5	950	95.0	9.5
10.0	1000	100.0	10.0

PEAK FLOW A-7 DAMAGE CENTER

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS



NOT AVAILABLE AT THIS TIME

END

FILMED

DTIC